11/1/2008 – 05387

Final

Sampling and Analysis Plan BT-11 Site 87 Site Investigation

Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No. N62470-02-D-3052
CTO-0207

November 2008

Prepared by
CH2MHILL

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Contract Task Order 0207

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Department of the Navy
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Under the

NAVFAC CLEAN III Program
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Prepared by

CH2MHILL

Virginia Beach, Virginia

SAP Worksheet #1—Title and Approval Page

Draft
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)
November 2008

BT-11 Site 87 Site Investigation
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Prepared for:
Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Prepared by:
CH2M HILL
5700 Cleveland Street, Suite 101
Virginia Beach, VA 23462

Prepared under:
NAVFAC CLEAN III Program
Contract N62470-02-D-3052
CTO-207

REVIEW SIGNATURES:____
DOUG BITTERMAN / CH2M HILL ACTIVITY MANAGER / DATE

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PAUL FAVARA / CH2M HILL PROGRAM QUALITY MANAGER / DATE

APPROVAL SIGNATURES:____
SHERRI ENG / NAVFAC QA OFFICER / DATE

Other Approval Signatures:__Laura D. Lampshire______________11/3/08_
LAURA LAMPSHIRE / CH2M HILL PROJECT MANAGER / DATE

____
JAN NIELSEN / NAVFAC MID-ATLANTIC RPM / DATE

____
JEFF CHRISTOPHER / MCAS CP IRPM / DATE

____
GEORGE LANE / NCDENR RPM / DATE

Executive Summary

This Sampling and Analysis Plan (SAP) is prepared to support the proposed Site Investigation (SI) at BT-11, Site 87, which is located at an offsite range complex associated with Marine Corps Air Station (MCAS) Cherry Point, North Carolina. The SI will be conducted as a series of quarterly field mobilizations to Site 87 over the course of one year. The first event will involve the installation of three permanent monitoring wells, which will subsequently be sampled, as well as the collection of four surface soil samples. The remaining three events will consist of the quarterly sampling of the three new monitoring wells. The objective of this investigation is to understand the occurrence of potential 4-methylphenol and lead contamination at Site 87.

In accordance with the Intergovernmental Data Quality Task Force (IDQTF) Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (IDQTF, 2005), this United States Navy (Navy)-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serve as guidelines for the field work and data quality. The site-specific laboratory and field standard operating procedures (SOPs) are located in Appendixes A through C of this SAP (on CD-ROM).

Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, is conducting the Site Investigation under a North Carolina State-led remediation project under the direction of the North Carolina Department of Environment and Natural Resources (NCDENR).

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the analytical laboratories that are currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by Empirical Laboratories. Additionally, data validation services will be provided by Environmental Data Services.

SAP Worksheets

Figures (located at the end of the document)

Appendixes

Abbreviations and Acronyms

3R	recognize, report, retreat
bgs	below ground surface
BT	Bombing Target
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	chain of custody
CPR	cardiopulmonary resuscitation
CRQL	Contract Required Quantitation Limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	Data Quality Indicators
EIS	Environmental Information Specialist
ft	foot/feet
FTL	Field Team Leader
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSP	Health and Safety Plan
IDL	Instrument Detection Limit
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
IP/FP	Implementation Plan/Fee Proposal
LCS	laboratory control sample
LTM	long-term monitoring
MCAS	Marine Corps Air Station
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
mg/kg	milligram per kilogram
MRP	Munitions Response Program
MS	matrix spike
MSD	matrix spike duplicate
NAVFAC	Naval Facilities Engineering Command
Navy	United States Navy
NC 2L GW	North Carolina 2L Groundwater Quality Standards
NC SSL	North Carolina Soil Screening Level
NCDENR	North Carolina Department of Environment and Natural Resources

NFA	No Further Action
NIRIS	Navy Installation Restoration Information Server
ORP	oxidation-reduction potential
PAL	Project Action Limit
PM	Project Manager
PQL	Practical Quantitation Limit
PRG	preliminary remediation goal
QAPP	Quality Assurance Project Plan
QC	quality control
QL	Quantitation Limit
RL	Reporting Limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SI	Site Investigation
SNEDD	Supplemental NIRIS Electronic Data Deliverable
SOP	Standard Operating Procedure
SSC-HW	Site Safety Coordinator- Hazardous Waste
SVOC	semivolatile organic compound
TBD	to be determined
TIC	tentatively identified compounds
UFP	Uniform Federal Policy
USEPA	Environmental Protection Agency
UXO	unexploded ordnance

SAP Worksheet #2—SAP Identifying Information

Site Name/Number: BT-11, Site 87
Operable Unit: (Not applicable)
Contractor Name: CH2M HILL
Contract Number: N62470-02-D-3052
Contract Title: Navy CLEAN III
Work Assignment Number: CTO-207

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Intergovernmental Data Quality Task Force (IDQTF) Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (IDQTF, 2005) and *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002)*.

2. Identify regulatory program: North Carolina state-led remediation project under the North Carolina Department of Environment and Natural Resources (NCDENR).

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	**Date**
Meeting held in Wilmington, NC, with George Lane (NCDENR), Bill Friedmann (CH2M HILL), Rodger Jackson (NAVFAC Mid-Atlantic), Jeff Christopher (Marine Corps Air Station [MCAS] Cherry Point Environmental Affairs Dept.), and Jan Nielsen (Naval Facilities Engineer Command [NAVFAC] Mid-Atlantic) to discuss George Lane's comments on the draft Corrective Action Plan (CAP) for Bombing Target (BT)-11, and to come to an agreement on the steps necessary to complete the CAP. The sampling elements of this investigation were determined during this meeting.	5/10/07

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Final Work Plan, Site Investigation at Point of Marsh BT-11 (Sites I-32, 86, 87, 88, and 89), Marine Corps Air Station Cherry Point, North Carolina	1999

6. List organizational partners (stakeholders) and connection with lead organization:

NAVFAC Mid-Atlantic, Lead Agency; Department of Defense (DoD), Land Owner; NCDENR, Lead and State Regulatory Agency.

7. Data Users: NAVFAC Mid-Atlantic, Lead Agency; DoD, Land Owner; NCDENR, Lead and State Regulatory Agency; Subcontractor (CH2M HILL).

All SAP Elements required for this project are described herein on the 37 UFP-SAP Worksheets. Therefore, the crosswalk table is not necessary for this project.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Janice Nielsen	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	Phone: (757) 322-8339 Fax: (757) 322-8280	Email: janice.nielsen@navy.mil (Mailing and FedEx address) Commander NAVFAC Midland Attn: Janice Nielsen LRA, Building C, NC IPT 6506 Hampton Boulevard Norfolk, VA 23508-1278	(A PANAGON number will be assigned when the final document is being prepared.)
George Lane	Project Manager (PM)	NCDENR	Work Phone: (919) 508-8462 Emergency Phone: (336) 202-8665 Fax: (919) 733-4811	Email: george.lane@ncmail.net Home Email: GeorgeL100@aol.com (Mailing and Fed Ex address) NCDENR, Superfund Section 401 Oberlin Road, Suite 150 Raleigh, NC 27605	

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Jeff Christopher	MCAS Cherry Point Installation Restoration Program (IRP) Project Manager	MCAS Cherry Point Environmental Affairs Department	Phone: (252) 466-4421 Fax: (252) 466-2000	Email: jeffrey.christopher@usmc.mil (Mailing address): MCAS Cherry Point PSC Box 8006 Cherry Point, NC 28533-0006 (FedEx address): MCAS Cherry Point Building 4223, Access Road Cherry Point, NC 28533-0006	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
Doug Bitterman	Activity Manager	CH2M HILL	(757) 671-6209 (703) 627-3291 (cell)	Doug.bitterman@ch2m.com	
Laura Lampshire	Project Manager	CH2M HILL	(301) 570-1042 (home) (301) 580-0027 (cell)	Laura.lampshire@ch2m.com	
Anita Dodson	Program Chemist	CH2M HILL	(757) 671-6218	Anita.dodson@ch2m.com	
Paul Favara	Program QA Manager	CH2M HILL	(352) 335-5877 x52396	Paul.favara@ch2m.com	
Megan Hilton	Project Chemist	CH2M HILL	(401) 619-2657	Megan.hilton@ch2m.com	
Genevieve Moore	Project Environmental Information Specialist (EIS)	CH2M HILL	(757) 671-6284	Genevieve.moore@ch2m.com	
Steve Beck	Health and Safety Officer	CH2M HILL	(414) 272-2426 x277	Steven.beck@ch2m.com	
To be determined (TBD)	Field Team Leader (FTL)	CH2M HILL	TBD	TBD	
TBD	Field Crew Members	CH2M HILL	TBD	TBD	
Marcia McGinnity	Project Manager	Empirical Laboratories	(615) 345-1115	mmcginnity@empirlabs.com	

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
TBD	IDW Disposal Subcontractor	TBD	TBD	TBD	
Nancy Weaver	Senior Chemist	Environmental Data Services (EDS)	(757) 564-0090	nweaver@env-data.com	

SAP Worksheet #4—Project Personnel Sign-Off Sheet

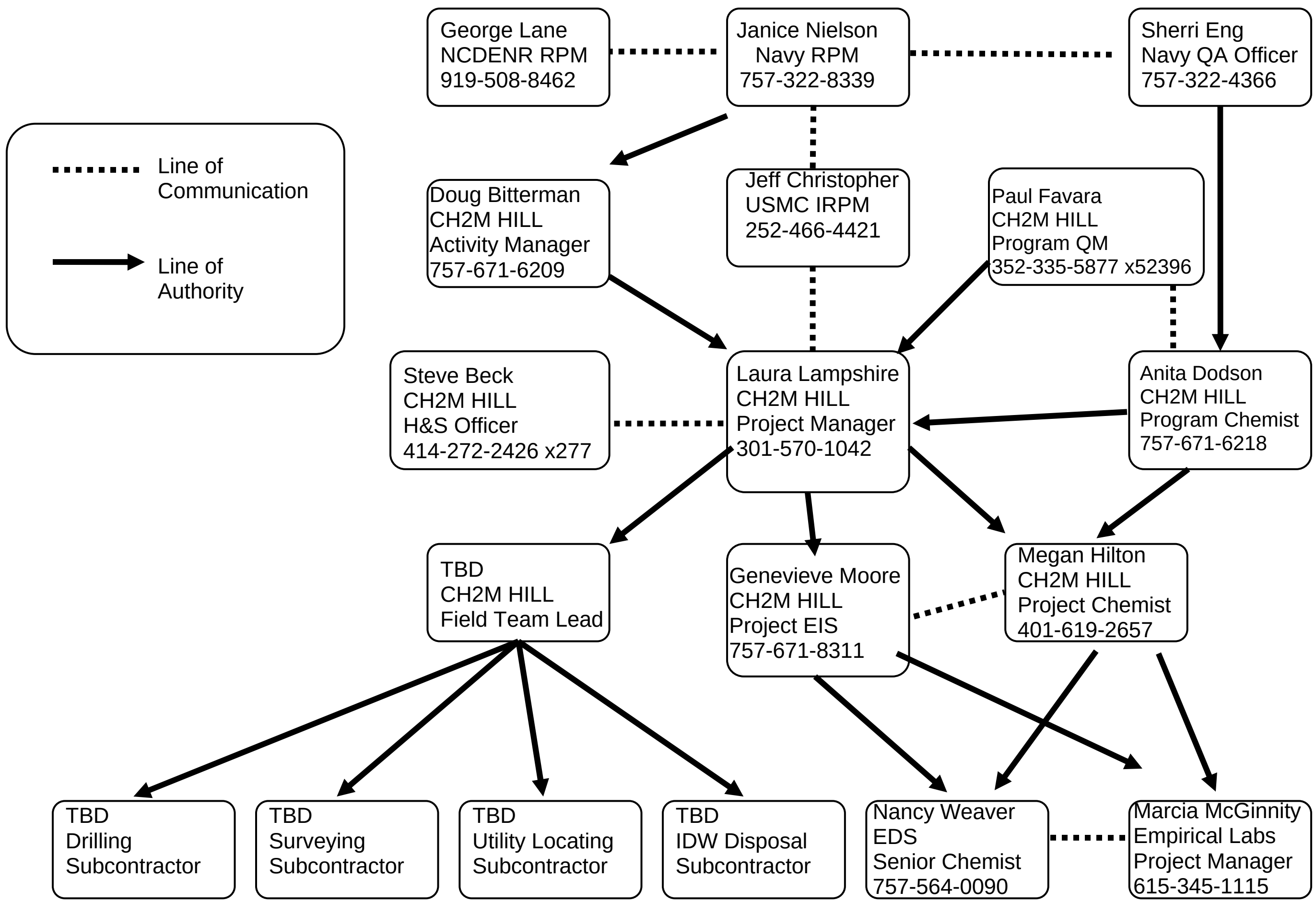
The key personnel listed below are required to read the SAP. The project manager will track this information and ensure that information from this completed sign-off sheet is included in the central project file.

Name	Organization/Title/Role	Telephone Number	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Janice Nielsen	Navy RPM	(757) 322-8339 (757) 617-0987 (cell)			
Jeff Christopher	MCAS Environmental Affairs Department/ IRPM	(252) 466-4421			
George Lane	NCDENR/ Project Manager	(919) 508-8462			
Doug Bitterman	CH2M HILL/Activity Manager	(757) 671-6209 (703) 627-3291 (cell)			
Laura Lampshire	CH2M HILL/PM	(301) 570-1042 (home) (301) 580-0027 (cell)	Laura D. Lampshire		11/3/08
Anita Dodson	CH2M HILL/Program Chemist	(757) 671-6218			
Paul Favara	CH2M HILL/Program Quality Manager	(352) 335-5877 x52396			
Megan Hilton	CH2M HILL/Project Chemist	(401) 619-2657			
Genevieve Moore	CH2M HILL/ Project EIS	(757) 671-6284			
Steve Beck	CH2M HILL/Health and Safety Officer	(414) 272-2426 x277			
To be determined (TBD)	CH2M HILL/Field Team Leader (FTL)	TBD			
TBD	CH2M HILL/Field Crew Members	TBD			
Marcia McGinnity	Empirical Laboratories/ Project Manager	(615) 345-1115			

SAP Worksheet #4—Project Personnel Sign-Off Sheet (continued)

Name	Organization/Title/Role	Telephone Number	Signature/email receipt	SAP Section Reviewed	Date SAP Read
TBD	IDW Disposal Subcontractor	TBD			
Nancy Weaver	EDS/Senior Chemist	(757) 564-0090			

SAP Worksheet #5—Project Organization Chart



SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Point of Contact with NCDENR	Navy RPM for MCAS Cherry Point	Janice Nielsen	(757) 322-8339	Primary point of contact for the Navy; All materials and information pertaining to the project will be forwarded to George Lane (NCDENR) by the RPM following review.
Environmental Manager	MCAS Cherry Point Installation Restoration Program (IRP) Project Manager	Jeff Christopher	(252) 466-4421	Oversees all IRP remedial activities at USMC Cherry Point. Any issues that may impact the Cherry Point operations are to be reported to him immediately.
Primary contact for CH2M HILL activities	CH2M HILL Activity Manager for MCAS Cherry Point	Doug Bitterman	(757) 671-6209	Primary point of contact for Navy and MCAS Cherry Point RPMs; oversees CH2M HILL project delivery for this project.
Manage all Project Phases	CH2M HILL Project Manager for this project	Laura Lampshire	(301) 570-1042 (home) (301) 580-0027 (cell)	Primary modes of communication are phone, email, letter, document submittal; timing dependent on nature of communication and pre-defined schedules, as applicable and as requested by stakeholder agencies. Implements changes to the SAP.
SAP changes in the field	FTL	(To be determined)	TBD	Notify the PM by phone and email of changes to the SAP made in the field and the reasons within 24 hours. Changes will be documented.
Daily Field Progress Reports	FTL	(To be determined)	TBD	Field Team Leader will email or fax daily field progress reports to contractor project managers on a weekly basis; telephone communication with project managers on as-needed basis.
Data tracking from collection through upload to database	Environmental Information Specialist (EIS)	Genevieve Moore	(757) 671-6284	EIS will track data from sample collection through upload to database, ensuring QAPP requirements are met by laboratory and field staff.
Reporting Lab Data Quality Issues	Laboratory Project Manager	Marcia McGinnity, Empirical Laboratory	(615) 345-1115	All QA/QC issues with project filed samples will be reported by the lab to the EIS, Project Chemist, and Contractor Quality Assurance Officer within 2 business days.
Field and Analytical Corrective Actions	Program Chemist	Anita Dodson	(757) 671-6218	The need for corrective action for field and analytical issues will be determined by the Field Team Leader and/or Contractor Quality Assurance Officer.
Release of Analytical Data	Project Chemist	Megan Hilton	(401) 619-2657	No analytical data can be released until validation is completed and the Project Chemist has approved the release.

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Janice Nielsen	RPM	U.S. Navy	Coordinates Environmental Restoration (CERCLA/MRP) activities for/on MCAS Cherry Point.	
Doug Bitterman	Activity Manager Senior Consultant	CH2M HILL	Responsible for CH2M HILL performance of Environmental Restoration Program work at MCAS Cherry Point Provides senior technical oversight to CH2M HILL staff	B.S. Geology M.S. Civil Engineering 19 years experience
Laura Lampshire	Project Manager	CH2M HILL	Directs and oversees staff	B.S. Geology and Mathematics M.S. Geophysics 15 years experience
Anita Dodson	Program Chemist	CH2M HILL	Responsible for audits, corrective action, checks of QA performance	B.S. Chemistry 14 years experience
Megan Hilton	Project Chemist	CH2M HILL	Performs oversight of laboratory and data validators; data usability evaluation	B.S. Chemistry and Environmental Science 2 yrs. experience
(To be determined)	FTL	CH2M HILL	Supervises field sampling and coordinates all field activities	(To be determined)
Steve Beck	Health and Safety Officer	CH2M HILL	Oversees H&S for field activities	M.S., Occupational Safety and Health 13 yrs. experience
Genevieve Moore	Environmental Information Specialist (EIS)	CH2M HILL	Manages sample tracking, coordinates with laboratory and data-validator, data management	B.S. Biology 0.5 yr experience
Marcia McGinnity	Laboratory PM	Empirical Laboratory	Manages analytical projects from initiation to completion	B.S. Chemistry and Science Education 20 yrs. experience
Nancy Weaver	Data Validation PM	Environmental Data Services	Performs analytical data review and validation	B.S. Chemistry 20 yrs. experience

SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Environmental Field Work	Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training 8-hour refreshers CPR/First Aid Site Safety Coordinator- Hazardous Waste (SSC-HW) training	Various registered organizations	Project-specific	FTL, and others TBD	FTL, Field team members, site-safety coordinators, all from CH2M HILL	CH2M HILL Human Resources Department
Environmental Field Work	3R (Recognize, Report, Retreat) Training	Internal to CH2M HILL (training DVD)	Project-specific	All field crew members	FTL, Field team members, site-safety coordinators, all from CH2M HILL	Document in personal Health and Safety Plan (HSP) file
Site Safety Coordinator	Site Safety Coordinator- Hazardous Waste Training	Internal to CH2M HILL	Every 3 years	At least one field crew member must be designated as the SSC	SSC/ CH2M HILL	CH2M HILL Human Resources Department
UXO Clearance Technician	Minimum qualification standards as described in the Department of Defense Explosives Safety Board, DDESB TP18, “Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, 20 December 2004, or latest edition. Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training 8-hour refreshers CPR/First Aid	U.S. Military Various registered organizations	During military service Project-specific	UXO Clearance Technician	UXO Clearance Technician, CH2M HILL	U.S. Military records CH2M HILL Human Resources Department

SAP Worksheet #9—Project Scoping Session Participants Sheet

Project Name: Groundwater Well Installation and Sampling, BT-11, Site 87 **Projected Date(s) of Sampling:** Summer 2008 **Project Manager:** Laura Lampshire			**Site Name:** BT-11, Site 87 **Site Location:** MCAS Cherry Point, North Carolina		
Date of Session: 5/10/07 **Scoping Session Purpose:** Meeting with NCDENR regulator to discuss his comments on a Corrective Action Plan (CAP) for Site 87. The regulator indicated the sampling he would like to see occur in order to feel comfortable proceeding with a CAP for the site, and NAVFAC Mid-Atlantic concurred with the proposed sampling elements that were identified during this meeting. Meeting was held in Wilmington, NC.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
George Lane	RPM	NCDENR	Work Phone: (919) 508-8462 Emergency Phone: (336) 202-8665 Fax: (919) 733-4811	Email: george.lane@ncmail.net Home Email: GeorgeL100@aol.com	Primary regulatory agency stakeholder
Janice Nielsen	RPM	NAVFAC Mid-Atlantic	Phone: (757) 322-8339 Fax: (757) 322-4530	Email: janice.nielsen@navy.mil	Manages ERN (CERCLA/MRP) activities for MCAS Cherry Point
Bill Friedmann	Activity Manager for MCAS Cherry Point	CH2M HILL	757-671-6223	William.Friedmann@CH2M.com	Oversee project work performed by CH2M HILL
Jeff Christopher	MCAS Cherry Point IRPM	MCAS Cherry Point Environmental Affairs Dept.	252-466-4421	jeffrey.christopher@usmc.mil	Manages IRP environmental activities at MCAS Cherry Point
Rodger Jackson	Supervisor, NC IPT	NAVFAC Mid-Atlantic	757-322-4589	rodger.jackson@navy.mil	Former NAVFAC Mid-Atlantic RPM

Comments/Decisions:

The meeting was conducted to discuss NCDENR comments on the draft Corrective Action Plan (CAP) for Site 87. The CAP proposed the implementation of land use restrictions as the remedy to address potential lead and 4-methylphenol contamination found during an earlier Site Investigation (SI) that included Site 87. The NCDENR comments on the Draft CAP raised questions about the results reported in the earlier SI report. During the meeting, the NCDENR regulator indicated that additional sampling activities for lead and 4-methylphenol would be necessary for him to feel comfortable proceeding with a CAP for Site 87. The sampling scheme laid out during this meeting, and that was agreed upon by the NCDENR RPM and the NAVFAC Mid-Atlantic RPM, is as presented in this SAP.

SAP Worksheet #9—Project Scoping Session Participants Sheet (continued)

In addition to the elements of the sampling activities, it was also agreed upon at this meeting that the results of the sampling would be captured in an SI Addendum rather than a new CAP that incorporated the sampling results. The strategy that was discussed during the meeting was that if the sample results come back below the soil screening levels (SSL) and North Carolina 2L Groundwater Quality Standards (NC 2L GW), the team would proceed to prepare a No Further Action (NFA) CAP. If the results come back indicating some site-related contamination in either soil or groundwater, the team would proceed to prepare a CAP that incorporated the new data in the remedy selection.

Action Items:

CH2M HILL was tasked with preparing a cost estimate to perform the well installation and soil and groundwater sampling as presented in this SAP. Permanent monitoring well installations rather than temporary wells were planned due to the multiple rounds of groundwater sampling included in the sampling scheme and due to the possibility for future sampling in the event LTM became part of a remedy for the site.

Consensus Decisions:

See the Comments/Decisions section above.

SAP Worksheet #10—Problem Definition

The Point of Marsh Bombing Target 11 (BT-11) is located on Piney Island, a marshy island in Pamlico Sound approximately 30 miles east of MCAS Cherry Point, North Carolina (Figure 2). BT-11 is affiliated with MCAS Cherry Point, and is presently used by the military for aerial target practice and is known to contain unexploded ordnance (UXO). There are four sites at BT-11 where the disposal of non-ordnance wastes may have occurred: Site I-32, Site 87, Site 88, and Site 89.

Tidal wetlands are prominent across BT-11, with upland areas occurring primarily adjacent to the gravel roadbeds. The upland areas are generally vegetated with grasses and undergrowth.

Site 87 refers to a former waste disposal area located approximately ¼-mile northwest of Building 9037, on the northeast side of the Main Road (Figure 3). This site is approximately 20 feet by 20 feet in area, and is predominantly marshy, except for an area immediately adjacent to the Main Road.

According to facility personnel, Site 87 originated as a disposal site when a bulldozer sank into the marsh and became stuck at that location, and upon being pulled out, the resulting depression was subsequently used as a disposal pit. The waste materials reported to possibly have been disposed of at Site 87 during the mid-1970s included batteries and motor oils.

Shallow soils beneath Site 87 were found to be generally silt to 4 feet below ground surface, and then underlain by saturated, silty sand to medium sand to 8 feet below ground surface. The first encountered groundwater occurs a few feet below the ground surface. No permanent groundwater monitoring wells have been installed at the site and the groundwater flow direction is unknown. However, based on the topography, the general direction of shallow groundwater flow is estimated to be towards Jacks Bay of the Pamlico Sound to the southeast.

Access to BT-11 is prohibited except for authorized personnel. Potential human receptors at Site 87 are BT-11 employees; specifically, the occupants of the buildings located on the eastern end of BT-11 near Jacks Bay. However, these human receptors have no direct contact with the soil at Site 87. No water supply wells are located within the impacted area of the site. The nearest residential areas are approximately 5 miles from BT-11, and one single water supply well is located within a 4-mile radius used for military personnel and staff at BT-11. This water supply well is screened from 400 to 430 feet below ground surface.

A Site Investigation (SI) conducted in 1999 and 2000 at Site 87 determined that lead in one of two soil samples (498 mg/kg) and from the sediment sample collected beneath the standing water of the site depression (292 mg/kg) exceeded the North Carolina soil screening level (NC SSL) (270 mg/kg) for the protection of groundwater. No lead was detected in any groundwater samples collected from temporary monitoring wells at Site 87. In addition, one SVOC, 4-methylphenol, exceeded the NC SSL (17.4 μg/kg) in the two soil samples collected (both 330 μg/kg). No 4-methylphenol or any SVOCs were detected in any of the groundwater samples.

SAP Worksheet #10—Problem Definition (continued)

The BT-11 SI report concluded that the only constituent of concern (COC) at Site 87 was lead in soil and sediment. While 4-methylphenol exceeded the NC SSL in two soil samples, the concentrations did not exceed the applicable residential or industrial human health risk-based screening criteria (EPA Region 9 Preliminary Remediation Goals [PRGs]), and no 4-methylphenol was detected in any of the groundwater samples, despite the very shallow water table at the site. The recommendation of the SI report with respect to Site 87 was that a Corrective Action Plan (CAP) be prepared to address lead contamination in soil. The BT-11 SI Report was finalized in January 2007 and approved by NCDENR.

In April 2007, a Draft CAP was submitted to NCDENR that proposed a preferred alternative for Site 87 to address lead contamination in soil using land use controls (LUCs) to eliminate or reduce pathways of exposure to soil and sediment at Site 87. The proposed LUCs included restricting land use at Site 87 to industrial uses only and prohibiting intrusive activities (e.g., excavation of the ground surface) except for monitoring purposes without prior approval from NCDENR.

In late April 2007, NCDENR submitted comments on the Draft CAP indicating that NCDENR was not comfortable with a remedy that did not include long-term monitoring (LTM) for lead and 4-methylphenol. On May 10, 2007, the Navy and NCDENR met to discuss NCDENR comments on the Draft CAP and to determine a path forward. During this meeting, the NCDENR RPM reiterated that he was not comfortable with a remedy for Site 87 that did not incorporate LTM for lead and 4-methylphenol. In addition, both the Navy and NCDENR indicated that they felt there was a strong possibility that additional soil and groundwater sampling at Site 87 would result in samples with COC concentrations below regulatory standards. Consequently, the Navy and NCDENR agreed to proceed with a supplemental investigation to collect additional soil and groundwater samples. The supplemental investigation was to include the collection of 4 soil samples to be analyzed for lead and 4-methylphenol. In addition, 3 permanent monitoring wells were to be installed and sampled during 4 quarterly rounds for lead and 4-methylphenol. It was also agreed that the results of this supplemental investigation would be reported in a SI Addendum report rather than preparing a revised draft of the CAP that incorporated the results. The Navy and NCDENR agreed that if the soil sample results were below NC SSLs and the 4 quarterly rounds of groundwater results were below the State groundwater quality standards, the Navy could proceed to prepare a CAP proposing No Further Action (NFA) for Site 87. If the results indicated exceedances of regulatory standards in either medium, the Navy would proceed to prepare a CAP that took into account the new data in the remedy selection for Site 87. Based on an evaluation of the data exceeding regulatory criteria, potential recommendations to be considered include: initiation of long-term groundwater monitoring; conducting a Remedial Investigation; preparation of an Engineering Evaluation/Cost Analysis (EE/CA) Report and potential interim remedial action; and/or imposing land use restrictions.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

The data will be used by the Navy (and its contractors), MCAS Cherry Point, and NCDENR. Scientists and engineers will evaluate the data for decision making and a chemist will evaluate the laboratory data quality.

What are the Project Action Limits (PALs)? (specific detailed list should be provided in WS#15)

The most conservative (lowest) values from the following screening criteria guidelines, as applicable, will be used as the PALs.

- Soil

	Screening Criteria for Soil		
Parameter	**NC SSL**	**Region 9 PRG – Industrial Soil**	**Region 9 PRG – Residential Soil**
Lead (mg/kg)	270	800	400
4-Methylphenol (µg/kg)	17.4	3,100,000	310,000

- Groundwater

	Screening Criteria for Groundwater		
Parameter	**NC2L**	**MCL**	**Region 9 PRGs**
Lead (µg/L)	15	15	15
4-Methylphenol (µg/L)	3.5	-	180

- Per North Carolina regulations (15A NCAC 02L.0202 (b)(1)), when the regulatory standard for a particular constituent is less than the practical quantitation limit (PQL), a concentration at or above the PQL constitutes a violation of the standard.
- A specific detailed list of PALs is provided in Worksheet 15

What will the data be used for?

The data will be used to determine whether lead and 4-methylphenol contamination are present in the soil and groundwater at BT-11, Site 87. Should concentrations above regulatory standards be detected, the data will be used to aid in the determination of a suitable remedy for the site.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?

- Soil and groundwater samples will be submitted to an EPA and State certified off-site laboratory for analysis.
- The target analytes are lead and 4-methylphenol.
- Groundwater samples will be collected using a low-flow sampling technique. Specific conductance, pH, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), and temperature will be measured in the field during well purging using a Horiba® U-22 Water Quality Meter. Field parameters will be measured to indicate that the water is representative of the aquifer.
- Soil samples will be collected by using a decontaminated sampling tool, such as a stainless-steel trowel, at a depth of 0-6 inches below ground surface (bgs).

How "good" do the data need to be in order to support the environmental decision?

The data will be of the quality necessary to provide technically sound and defensible assessments of potential risks to human receptors. The data will be validated by a third-party validator using national functional guidance, methodology, and laboratory SOPs as appropriate. Project-specific quality objectives and SW846 8270C and 6010B methodology along with laboratory SOPs will be used to validate the data. Data validation qualifiers that are provided in the National Functional Guidelines will be applied as appropriate.

All samples will be analyzed offsite for lead and 4-methylphenol analysis at the lowest detection limits feasible. The collected data will be compared to specific regulatory screening criteria (see Worksheet #15). If the laboratory is not able to achieve PQLs below screening criteria, it will report down to the Method Detection Limit (MDL) and qualify the estimated result with a "J" flag if it is between the MDL and the PQL. North Carolina regulations (15A NCAC 02L.0202 (b)(1)) state that when the PQL for a constituent exceeds the State standard, the PQL serves as the standard.

How much data should be collected (number of samples for each analytical group, matrix, and concentration)?

The investigation at Site 87 will consist of four quarterly events:

- **Event 1—**four surface soil, three groundwater samples, and one investigation-derived waste soil sample
- **Event 2—**three groundwater samples
- **Event 3—**three groundwater samples
- **Event 4—**three groundwater samples

All samples will be analyzed only for lead and 4-methylphenol.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Where, when, and how should the data be collected/generated?

- Samples will be collected at Site 87 over a period of 1 year. Events are expected to take place every 3 months beginning in mid to late 2008.
- Data will be collected and generated in accordance with the procedures outlined in this UFP-SAP. Specifically, see the SOPs in Appendixes A through C for more details.

Who will collect and generate the data? How will the data be reported?

- CH2M HILL field staff will collect the samples.
- Chemical analytical data will be generated at the offsite analytical laboratory.
- The data report will include a Contract Laboratory Program (CLP) Level IV- equivalent package. This will include a Supplemental Naval Installation Restoration Information Solution Electronic Data Deliverable (SNEDD) deliverable in Microsoft Excel format and a hardcopy of the raw data.

How will the data be archived?

The data will be archived in accordance with Navy Guidance. At the end of the project, archived data will be returned to the Navy.

List the PQOs in the form of if/then qualitative and quantitative statements.

The results of this investigation will be used to determine whether or not corrective action is necessary for Site 87 at BT-11.

- If the detected soil and groundwater sample concentrations from this investigation are *below* their respective NC SSLs and NC Groundwater Quality Standards, then a CAP will be prepared for BT-11, Site 87 recommending No Further Action (NFA) for the site.
- If any detected soil and groundwater sample concentrations from this investigation are *above* their respective NC SSLs and NC Groundwater Quality Standards, then a CAP will be prepared for BT-11, Site 87 recommending a suitable remedy for the site or recommending additional data collection activities that are necessary in order to evaluate remedial alternatives. Based on an evaluation of the data exceeding regulatory criteria, potential recommendations to be considered include: initiation of long-term groundwater monitoring; conducting a Remedial Investigation; preparation of an Engineering Evaluation/Cost Analysis (EE/CA) Report and potential interim remedial action; and/or imposing land use restrictions.

The decision tree is included in Figure 1.

SAP Worksheet #12-1—Measurement Performance Criteria Table

Matrix: Surface Soil
SVOA (4-methylphenol)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Method Blank	SVOA	One every 12 hours prior to sample analysis	Bias / Contamination	No target analytes ≥1/2 QL	A
Laboratory Control Spike		One per 20 samples	Accuracy / Bias	Will be spiked with 4-methylphenol at a concentration of 3.3 mg/kg; % recovery should be 40-105%	A
Surrogate Standards		3 per sample, all samples	Accuracy / Bias	Surrogates within: 2-Fluorobiphenyl: 45-105% Terphenyl-d14: 30-125% 2,4,6-Tribromophenol: 35-125% 2-Fluorophenol: 35-105% Phenol-d5/d6: 40-100% Nitrobenzene-d5: 35-100%	A
DFTPP tune		Prior to calibration or analysis	Accuracy / Bias / Precision	Degradation of DDT to DDE and DDE must not exceed 20%. Benzidine and pentachlorophenol should be present at their normal responses, and no peak tailing should be visible.	A
Internal Standards		3 per sample	Accuracy / Bias / Precision	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.	A
Matrix spike/matrix spike duplicate		1 per 20 samples	Accuracy / Bias / Precision	Will be spiked with 4-methylphenol at a concentration of 3.3 mg/kg; % recovery should be 40-105%, 30% RPD.	A
Field Duplicates		1 per 10 field samples	Precision	Values >5X QL: ± 30%	S & A
Equipment Rinsate Blanks		1 per day of sampling	Bias / Contamination	No target analytes ≥QL	S & A
Cooler Temperature Indicator		One per cooler shipped to laboratory	Accuracy / Representativeness	Between 2 and 6 degrees C.	S
Comparability Check		All results	Comparability	Values >5X QL: Field Replicates ± 30%	S & A

QL = Quantitation Limit
RPD = Relative Percent Difference

SAP Worksheet #12-2—Measurement Performance Criteria Table

Matrix: Surface Soil
Metals (Lead)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Method Blank	Metals	Every 12 hours prior to sample analysis	Bias / Contamination	No target analytes ≥1/2 QL	A
Laboratory Control Sample		One every 20 samples	Accuracy / Bias	Will be spiked with lead at a concentration of 50 mg/kg; % recovery should be 80-120%; ±20% of true value	A
Matrix Spike Sample		One every 20 samples	Accuracy / Bias	Will be spiked with lead at a concentration of 50 mg/kg; % recovery should be 80-120%; ±25% of true value if sample <4x spike added	A
Duplicate		One per digestion batch of 20 or fewer samples.	Precision	Values ≥5X QL: RPD ≤20%.	A
ICP Serial Dilution		One per digestion batch	Accuracy / Bias	If original samples result is at least 50x IDL, 5-fold dilution must agree within ±10% of the original result.	A
Field Duplicates		One per 10 field samples	Precision	Values ≥5X QL: RPD ≤30%.	S & A
Equipment Rinsate Blanks		One per day of sampling	Bias / Contamination	No target analytes ≥QL	S & A
Cooler Temperature Indicator		One per cooler to the laboratory	Accuracy / Representativeness	Between 2 and 6 degrees C.	S
Comparability Check		All results	Comparability	Values ≥5X QL: Field Duplicates; RPD ≤30%.	S & A

QL = Quantitation Limit
RPD = Relative Percent Difference

SAP Worksheet #12-3—Measurement Performance Criteria Table

Matrix: Groundwater
SVOA (4-methylphenol)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Method Blank	SVOA	One every 12 hours prior to analysis	Bias / Contamination	No target analytes ≥1/2 QL	A
Laboratory Control Spike		One per 20 samples	Accuracy / Bias	Will be spiked with 4-methylphenol at a concentration of 50 µg/L; %recovery should be 30-110%	A
Surrogate Standards		3 per sample, all samples	Accuracy/ Bias	Surrogates within: 2-Fluorobiphenyl: 50-110% Terphenyl-d14: 50-135% 2,4,6-Tribromophenol: 40-125% 2-Fluorophenol: 20-110% Nitrobenzene-d5: 40-110%	A
Internal Standards		3 per sample	Accuracy / Bias / Precision	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.	A
Matrix spike/matrix spike duplicate		One per 20 samples	Accuracy / Bias / Precision	Will be spiked with 4-methylphenol at a concentration of 50 µg/L; %recovery should be 30-110%; 30% RPD.	A
Field Duplicates		One per 10 field samples	Precision	Values >5X QL: ± 25%	S & A
Equipment Rinsate Blanks		One per day of sampling	Bias / Contamination	No target analytes ≥QL	S & A
Cooler Temperature Indicator		One per cooler to the laboratory	Accuracy / Representativeness	Between 2 and 6 degrees C.	S
DFTPP tune		Prior to calibration or analysis	Accuracy / Bias / Precision	Degradation of DDT to DDE and DDE must not exceed 20%. Benzidine and pentachlorophenol should be present at their normal responses, and no peak tailing should be visible.	A
Comparability Check		All results	Comparability	Values >5X QL: Field Replicates ± 25%	S & A

QL = Quantitation Limit
RPD = Relative Percent Difference

SAP Worksheet #12-4—Measurement Performance Criteria Table

Matrix: Groundwater
Metals (Lead)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Method Blank	Metals	One every 12 hours prior to analysis	Bias / Contamination	No target analytes ≥1/2 QL	A
Laboratory Control Sample		One per 20 samples	Accuracy / Bias	Will be spike with lead at a concentration of 250 µg/L; %recovery should be 80-120%; ±20% of true value	A
Matrix Spike Sample		One per 20 samples	Accuracy / Bias	Will be spike with lead at a concentration of 250 µg/L; %recovery should be 80-120%; ±25% of true value if sample <4x spike added	A
Duplicate		One per 20 samples	Precision	Values ≥5X QL: RPD ≤20%.	A
ICP Serial Dilution		One per digestion batch	Accuracy / Bias	If original samples result is at least 50x IDL, 5-fold dilution must agree within ±10% of the original result.	A
Field Duplicates		One per 10 field samples	Precision	Values ≥5X QL: RPD ≤25%.	S & A
Equipment Rinsate Blanks		One per day of sampling	Bias / Contamination	No target analytes ≥QL	S & A
Cooler Temperature Indicator		One per cooler to the laboratory	Accuracy / Representativeness	Between 2 and 6 degrees C, preserved with HNO_3 to pH 2.	S
Comparability Check		All results	Comparability	Values ≥5X QL: Field Duplicates; RPD ≤25%.	S & A

QL = Quantitation Limit
RPD = Relative Percent Difference

SAP Worksheet #12-5 - Measurement Performance Criteria Table

Matrix: Solid
TCLP-Volatiles

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	TCLP-VOCs	One per batch	Bias / Contamination	No target analytes > Quantitation Limit; surrogates within: 4-bromofluorobenzene: 85-120% Toluene-d8: 85-115% 1,2-Dichloroethane-d4: 80-135% Dibromofluoromethane: 85-120%	A
Surrogate Standards		In each sample and QC analysis	Accuracy / Bias	surrogates within: 4-bromofluorobenzene: 85-120% Toluene-d8: 85-115% 1,2-Dichloroethane-d4: 80-135% Dibromofluoromethane: 85-120%	A
Internal Standards		In each sample and QC analysis	Accuracy / Bias / Precision	Area counts –50% to +100% of initial calibration IS or continuing calibration IS area counts; Retention times +/- 30 secs of CC	A
Lab control sample/lab control sample duplicate		One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Accuracy / Bias / Precision	Benzene: 80-120% Carbon tetrachloride: 65-140% Chlorobenzene: 80-120% Chloroform: 65-135% 1,4-Dichlorobenzene: 75-125% 1,2-Dichloroethane: 70-130% 1,1-Dichloroethene: 70-130% 2-Butanone: 30-150% Tetrachloroethene: 45-150% Trichloroethene: 70-125% Vinyl Chloride:50-145%	A
Matrix spike/matrix spike duplicate		One set per 20 field samples	Accuracy / Bias / Precision	Acceptance criteria from LCS/LCSD	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-6 - Measurement Performance Criteria Table

Matrix: Solid
TCLP-Semivolatiles

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	TCLP-SVOCs	One per batch	Bias / Contamination	No target analytes > Quantitation Limit; Surrogates within: 2-Fluorobiphenyl: 35-110% Terphenyl-d14: 55-120% 2,4,6-Tribromophenol: 45-125% 2-Fluorophenol: 15-110% Phenol-d5/d6: 15-110% Nitrobenzene-d5: 30-110%	A
Surrogate Standards		In each sample and QC analysis	Accuracy / Bias	Surrogates within: 2-Fluorobiphenyl: 35-110% Terphenyl-d14: 55-120% 2,4,6-Tribromophenol: 45-125% 2-Fluorophenol: 15-110% Phenol-d5/d6: 15-110% Nitrobenzene-d5: 30-110%	A
Internal Standards		In each sample and QC analysis	Accuracy / Bias / Precision	Area counts –50% to +100% of initial calibration IS or continuing calibration IS area counts; Retention times +/- 30 secs of CC	A
DFTPP tune		Prior to calibration or analysis	Accuracy / Bias / Precision	Degradation of DDT to DDE and DDE must not exceed 20%. Benzidine and pentachlorophenol should be present at their normal responses, and no peak tailing should be visible.	A
Lab control sample/lab control sample duplicate		One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Accuracy / Bias / Precision	2-methylphenol: 40-110% 4-methylphenol: 30-110% 2,4-Dinitrotoluene: 50-120% Hexachlorobenzene: 50-110% Hexachlorobutadiene: 25-105% Hexachloroethane: 30-95% Nitrobenzene: 45-110% Pentachlorophenol: 40-115% Pyridine: 25-120% 2,4,5-Trichlorphenol: 50-110% 2,4,6-Trichlorophenol: 50-115%	A
Matrix spike/matrix spike duplicate		One set per 20 field samples	Accuracy / Bias / Precision	Use acceptance criteria from LCS/LCSD	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-7 - Measurement Performance Criteria Table

Matrix: Solid
TCLP-Pesticides

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	TCLP-Pesticides	One per batch	Bias / Contamination	No target analytes > Quantitation Limit; surrogates within: Decachlorobiphenyl: 25-130% TCMX: 25-120%	A
Surrogate Standards		In each sample and QC analysis	Accuracy / Bias	surrogates within: Decachlorobiphenyl: 25-130% TCMX: 25-120%	A
Lab control sample/lab control sample duplicate		One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Accuracy / Bias / Precision	Endrin: 55-135% Heptachlor: 40-130% Heptachlor epoxide: 60-130% Gamma-BHC: 25-135% Methoxychlor: 55-150% Chlordane: 45-119% Toxaphene: 41-126%	A
Matrix spike/matrix spike duplicate		One set per 20 field samples	Accuracy / Bias / Precision	Use acceptance criteria from LCS/LCSD	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-8 - Measurement Performance Criteria Table

Matrix: Solid
TCLP-Herbicides

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	TCLP-Herbicides	One per batch	Bias / Contamination	No target analytes > Quantitation Limit; Surrogates within: DCAA: 20-140%	A
Surrogate Standards		In each sample and QC analysis	Accuracy / Bias	Surrogates within: DCAA: 20-140%	A
Lab control sample/lab control sample duplicate		One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Accuracy / Bias / Precision	2,4-D: 35-115% 2,4,5-TP: 50-115%	A
Matrix spike/matrix spike duplicate		One set per 20 field samples	Accuracy / Bias / Precision	Use acceptance criteria from LCS/LCSD.	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-9 - Measurement Performance Criteria Table

Matrix: Solid
TCLP-Metals

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	TCLP-Metals	One per batch	Bias / Contamination	No target analytes > Quantitation Limit	A
Lab control sample/lab control sample duplicate		One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Accuracy / Bias / Precision	%Recovery 80% - 120%	A
Matrix spike		One set per 20 field samples	Accuracy / Bias	%Recovery 80% - 120%	A
Post-Digestion Spike		For elements outside of QC limits in matrix spike	Accuracy/Bias	%Recovery 75% - 125%	A
ICP Serial Dilution		Per analytical run for ICP	Accuracy/Bias	%Difference 90% - 110%	A
Duplicate		One set per 20 field samples	Precision	Relative Percent Difference <=20%	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-10 - Measurement Performance Criteria Table

Matrix: Solid

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Lab control sample (pH 7.0 buffer)	Corrosivity	Every 10 samples	Accuracy / Bias	+/- 0.05 pH units	A
Duplicate		One set per 20 field samples	Precision	Relative Percent Difference <=20%	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-11 - Measurement Performance Criteria Table

Matrix: Solid

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Lab control sample	Ignitability	One per batch of 20 or fewer samples	Accuracy / Bias	%Recovery 80% - 120%	A
Duplicate		One set per 20 field samples, for every sample that flashes, or extinguishes flame <140 degrees	Precision	Relative Percent Difference <=20%	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #12-12 - Measurement Performance Criteria Table

Matrix: Solid

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method Blank	Reactivity	One per batch	Bias / Contamination	No target analytes > Quantitation Limit	A
Lab control sample		One per batch of 20 or fewer samples	Accuracy / Bias / Precision	Reactive sulfide = %Recovery 22% - 114%, Reactive cyanide = %Recovery 0% - 12.4%	A
Cooler Temperature Indicator		One per cooler	Accuracy / Representativeness	Between 2 and 6 degrees C.	S

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
BT-11, Site 87 Historical Data	CH2M HILL, Inc., *Final Site Investigation Report, Point of Marsh BT-11 (Sites I-32, 87, 88, and 89), Marine Corps Air Station, Cherry Point, North Carolina*, January 2007	CH2M HILL, Inc. Surface soil, sediment, and groundwater samples collected in 1999 and 2000	Data used to determine the proposed sample locations for the UFP-SAP and for comparison against analytical data to be collected in the near future	None known

SAP Worksheet #14—Summary of Project Tasks

Major tasks associated with the Site 87 sampling effort:

Mobilization/Demobilization

Following approval of the SAP, CH2M HILL will begin mobilization activities. Prior to mobilization (2 weeks), NAVFAC, MCAS Cherry Point, NCDENR, and USEPA will be notified to allow for appropriate oversight and coordination. All field team members will review the appropriate master planning documents (including the Master FSP (AQVIQ/CH2M HILL, 2004a) and the Master QAPP (AQVIQ/CH2M HILL, 2004b), along with this SAP and project-specific Health and Safety Plan (HSP). A field team kickoff meeting will be held prior to mobilization to ensure that personnel are familiar with the scope of field activities and safety issues.

Mobilization activities include obtaining utility clearance for proposed sampling locations, coordination with base personnel and subcontractors, and preparation of field equipment. Demobilization activities will include review of chains of custody to ensure that all analytical samples were collected as planned and submitted for the appropriate analysis and packaging and shipment of rental equipment for return to the appropriate vendors. These activities will be conducted in accordance with the FSP referenced above.

Munitions and Explosives of Concern (MEC)

MEC Awareness. Based on CH2M HILL's risk evaluation for this project, there is only a remote possibility that munitions and explosives of concern (MEC) could be encountered at Site 87 based on documented historical activities at BT-11. However, given BT-11's historical use as an aerial practice target area, an Unexploded Ordnance (UXO) Technician will be present during all intrusive field activities (e.g., soil sampling, monitoring well installation). In addition, all personnel will complete 3R (recognize, retreat, report) training prior to the start of field efforts.

In the unlikely event that MEC is discovered, the Navy Remedial Project Manager (RPM) will be notified and field sampling activities will be immediately suspended. The MEC item will be fully described (if known or able to be determined) by the UXO Technician by noting the geographic coordinates using Global Positioning System (GPS), item group, item class, item category, filler type, fuse condition, whether the item requires demolition/demilitarization, the date and time found, and any comments that will assist in making a decision about how to proceed. The handling and/or management of the MEC will be conducted by a United States Marine Corps Explosive Ordnance Disposal (EOD) team.

SAP Worksheet #14—Summary of Project Tasks (continued)

Access routes to sampling locations. Prior to sampling or well drilling crews on site, the UXO Technician will conduct a reconnaissance of the sampling area. The reconnaissance will include locating the designated sampling or drilling location(s) and insuring that they are free of anomalies. If anomalies are detected the point will be relocated as directed. Once the designed point has been cleared, an access route for the sampling crew's vehicles and equipment will be cleared. The access route, at a minimum will be twice the width of the widest vehicle and the boundaries will be clearly marked to prevent personnel from straying into non cleared areas. If surface MEC is encountered, the UXO Technician will mark and report the item and divert the approach path around the MEC. A magnetometer will be used to ensure there are no subsurface MEC with the approach path. If a subsurface magnetic anomaly is encountered, it will be assumed to be a possible MEC and the path diverted to avoid it.

Soil Sampling and Well Drilling Sites. The UXO Technician will clear a work site for soil samples and well drilling and clearly mark the boundaries. The area will be large enough to accommodate the drilling equipment and provide a work area for the crews. As a minimum, the cleared area will be a square, with a side dimension equal to twice the length of the largest vehicle or piece of equipment for use on site. If a pre-selected area indicates magnetic anomalies, a new sampling / drill site will be chosen. A down-hole magnetometer (or equivalent) check will be made every one foot to a maximum depth of 15 feet.

Soil Sampling and Analysis

Surface soil samples will be collected from four locations (one sample per location) as shown in Figure 5. Three of these locations will be evenly distributed surrounding the site, and one sample will be collected from the approximate center of the disposal area.

A decontaminated sampling tool, such as a stainless-steel trowel, will be used to collect surface soil samples. One surface soil sample will be collected at each soil sample location, from the unsaturated zone (estimated to be 0–5 ft bgs). Where no unsaturated zone exists and marshy conditions prevail, a saturated surface sample (i.e., sediment sample) will be collected.

The CH2M HILL field personnel will prepare a detailed sketch during field activities of apparent site boundaries, observed surface features, and sampling locations. A visual description of the soil will be logged and samples will be packed into laboratory-prepared sample containers. Soil samples will be submitted to an offsite laboratory for the analysis of 4-methylphenol and lead.

Monitoring Well Installation

Three permanent monitoring wells (87MW01, 87MW02, and 87MW03) will be installed at Site 87. Due to the small size of this site, the monitoring wells will be installed at three evenly distributed locations surrounding the apparent disposal area to assess groundwater quality entering and exiting the site. These locations are identified on Figure 5 and are co-located with the three soil samples proposed around the site boundary.

SAP Worksheet #14—Summary of Project Tasks (continued)

Each new monitoring well will be constructed with 2-inch inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) screen and riser. Monitoring well screens will be machine-slotted (0.010-inch), 10 ft long, and will be placed such that the top of the screen is at or near the water table. The final screen interval will be determined in the field by the onsite geologist. A silica sand filter pack will be placed within the annular space surrounding the well screen from the bottom of the boring extending to 2 ft above the top of the screen. A 2-ft thick bentonite layer will be placed at the top of the sand pack. If there is remaining annular space below the ground surface, after the bentonite has been hydrated, a cement-bentonite grout will be used to fill the remaining annular space. The monitoring wells will be completed with an above-grade surface casing and a locking cap will be placed at the top of the PVC riser pipe and the wells will be clearly marked with their respective well identifiers. A small hole will be drilled in the PVC riser pipe of each well, near the top but below the locking cap, to vent the well to the atmosphere.

During monitoring well installation, a CH2M HILL geologist will observe and record soil descriptions that include grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information, including possible evidence of contamination. Monitoring well boring logs and well construction logs will be completed by the field geologist during each well installation. Details of monitoring well installation and groundwater sampling procedures can be found in the SOPs, *GH-1, Soil and Rock Drilling Methods* and *Low-Flow Groundwater Sampling from Monitoring Wells.*

The newly installed wells will be developed prior to sampling. Well development will be accomplished using a combination of surging throughout the well screen followed by pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced.

Groundwater Sampling and Analysis

Groundwater samples will be collected from the three new wells at Site 87 immediately following installation of the monitoring wells and during three subsequent quarterly rounds of groundwater monitoring. Samples will be collected for laboratory analysis of 4-methylphenol and lead (total).

The wells to be sampled (87GW01, 87GW02, and 87GW03) are shown on Figure 5. Prior to sampling, the depth to groundwater in each well will be gauged using an electronic water level indicator. The depth-to-groundwater measurements will be recorded to the nearest 0.01-ft. Samples will be collected using a peristaltic pump and low-flow purging and sampling methodology as described in Worksheets #18 and #20. Wells will be purged prior to sample collection. During purging, field geochemical parameters (e.g., dissolved oxygen [DO], oxidation/reduction potential [ORP], temperature, conductivity, pH, turbidity, salinity) will be collected using a Horiba U-22 water quality meter in accordance with Worksheets #21 and #22. Purging will continue until geochemical parameters stabilize to within 10 percent between subsequent readings collected at least 5 minutes apart. Samples will be contained in laboratory-prepared, pre-preserved sample bottles and packed on ice for overnight shipment to Empirical Laboratory as shown in Worksheet #19.

SAP Worksheet #14—Summary of Project Tasks (continued)

Surveying

The locations of the monitoring well and soil borings will be surveyed by a licensed professional surveyor for horizontal control, and the monitoring wells will also be surveyed for vertical control. Specifically, the top of the PVC well casing on all monitoring wells will be surveyed for water-level measurement purposes and a mark or notch will be inscribed in the PVC well casing to indicate the surveyed point. Details on land surveying can be found in the SOP, *Civil Surveying*.

Decontamination

Unless disposable, all equipment involved in field investigation activities will be decontaminated upon arrival at the site, between sampling locations, and at the conclusion of investigation activities. Stainless steel sample equipment will decontaminated using the following series of washings/rinses:

1. Rinse and scrub with potable water
2. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox™ solution
3. Rinse with potable water
4. Rinse with distilled or potable water and methanol solution
5. Air dry
6. Rinse with deionized water
7. Air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately

Nitric acid solution will not be used in the decontamination processes due to potential health and safety concerns and because an acid solution can leach metals from metallic equipment. Details on procedures for decontamination can be found in the SOPs, *Decontamination of Personnel and Equipment* and *Decontamination of Drilling Rigs and Equipment.*

Investigation-Derived Waste Management

All investigation-derived waste (IDW) generated will be managed during the investigation in accordance with Section 2.12 of the Master FSP (AQVIQ/CH2M HILL, 2004a). IDW is expected to consist of disposable equipment, drill cuttings, and water from well development and the decontamination of sampling equipment generated during sampling activities. The solid and aqueous IDW will be containerized in 55-gallon drums, which will be labeled in accordance with Page 654 of Appendix B of the Master FSP (AQVIQ/CH2M HILL, 2004a). All aqueous IDW will be disposed of at the MCAS Cherry Point Industrial Wastewater Treatment Plant (IWTP). Solid IDW consisting of drill cuttings will be transported to MCAS Cherry Point and staged at the drum storage area designated by the Environmental Affairs Department (EAD). Finally, non-hazardous disposable items (personal protective equipment [PPE], other disposable supplies, trash) will be deposited in an approved onsite dumpster.

SAP Worksheet #14—Summary of Project Tasks (continued)

One composite sample of the soil cuttings will be collected for the purpose of IDW characterization, and will be analyzed for full toxicity characteristic leachate procedure (TCLP), ignitability, corrosivity, and reactivity analyses. The drum(s) containing the drill cutting IDW will be disposed of by a subcontractor within 90-days of generation, based on the results of the waste characterization analyses. The IDW subcontractor has not yet been determined for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

A full suite of IDW parameters has been included in this SAP. Once the IDW subcontractor has been identified, the list of parameters will be reexamined according to the specific disposal facility's requirements for waste characterization.

Station Identification System. Field station identification data are information assigned to a physical location in the field at which some sort of sample is collected. For example, a monitoring well that has been installed will require a name that will uniquely identify it with respect to other monitoring wells or other types of sample locations. The station name provides a key in a database to which any samples collected from that location can be linked to form a relational database structure.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are Facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, Location Type, Sequential Location Number, and possibly an additional qualifier.

Sample Identification System. Field sample identification data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples, the Field Team Leader (FTL) will review the proposed level of effort and create a list of unique sample identification names, or sample identifiers.

A standardized numbering system will be used to identify all samples collected during sampling activities. The numbering system will provide a tracking procedure to ensure accurate data retrieval of all samples collected. A list of the sample identification numbers will be maintained by the FTL, who will be responsible for enforcing the use of the standardized numbering system during all sampling activities.

This sample designation format will be followed throughout the field activities conducted at Site 87. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample Packaging and Shipping. Samples will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via overnight courier. The FTL will be responsible for completion of the following forms:

- Sample labels and chain-of-custody (COC) seals
- COC forms
- Appropriate labels and forms required for shipment

SAP Worksheet #14—Summary of Project Tasks (continued)

Custody of the samples will be maintained and documented at all times. COC documentation will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

Laboratory and Data Validation

All analyses will be conducted at Empirical Laboratories, a laboratory that has been evaluated by Navy Facilities Engineering Service Center (NFESC) personnel (see Worksheet 31). A signed certificate of analysis will be provided in the narrative section of each laboratory data package. The laboratory will submit the data in hard copy and an electronic format. CH2M HILL will manage the data according to the Navy CLEAN Data Management Plan (Appendix C).

Analytical results will be validated against method QA/QC criteria and project specific criteria presented in this SAP by Environmental Data Services. Data that should be qualified will be flagged appropriately. Results for QA/QC samples will be reviewed and the data will be qualified further, if necessary. Finally, the data set as a whole will be examined for consistency, anomalous results, reasonableness, and utility. The data validator will be provided with the hard copy and electronic version of the laboratory results and will add data validation qualifiers to both versions. The electronic version will be examined for completeness and accuracy and compared to the hardcopy results by Megan Hilton, project chemist, and then loaded into the CH2M HILL master database.

Health and Safety Plan (HASP)

A project specific HASP will be prepared prior to commencement of field activities, and will be utilized in the field.

Evaluation and Reporting

Human health evaluation of lead exposure risk is based on blood-lead uptake using a physiologically based pharmakokinetic model referred to as the Integrated Exposure Uptake Biokinetic (IEUBK) model. A lead concentration of 400 mg/kg (the USEPA Region 9 Residential PRG) is typically used to screen soil. In the event of a lead concentration in excess of 400 mg/kg at a site, the IEUBK model is used to determine if the concentrations are adequately protective of human health. Concentrations of less than 400 mg/kg in soil are considered adequately protective of human health under residential land-use conditions.

In addition, detected lead and 4-methylphenol concentrations will be screened against the regulatory screening criteria identified in Table 4 to determine if a release has occurred that may pose unacceptable risk. If constituent concentrations do not exceed these screening criteria, it will be concluded that any release does not represent an unacceptable risk to human health and/or the environment and that no further action is warranted. If it is determined that a release has occurred that may pose potential unacceptable risk, the Navy, Marine Corps, and NCDENR team will be consulted.

Figure 1 provides a decision tree summarizing the process for evaluating the data from the SI and determining the path forward.

SAP Worksheet #14—Summary of Project Tasks (continued)

Procedures for recording data, including guidelines for recording and correcting data:

- See the *EIS Checklist for Validated and Unvalidated EDDs/SNEDDs and Hard Copy Data Checklist* in Appendix C of this UFP-SAP for examples of CH2M HILL's hardcopy data reporting forms and verification checklists.
- See the document *SNEDD Format* in Appendix C for an example of CH2M HILL's Navy CLEAN EDD format.

Computerized and manual procedures of data generation to final use and storage and QC checks for error detection to ensure data integrity:

The following documents (found in Appendix C) provide guidance on these procedures:

- *EIS QC Checklist for Unvalidated and Validated EDDs/ SNEDDs and Hard Copy Data Checklist*
- *EDD Prep for Raw and Detects Tables for Unvalidated or Validated Data*
- *EDD Prep for Load and Archive Files*

Guidance on data management steps such as data recording, data transformation, data reduction, data transfer and transmittal, data analysis, and data review:

Found in the Data Management Checklist and Navy CLEAN Data Management Plan (found in Appendix C).

Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data:

See the Data Management Checklist, EnStat Instructions, and Navy CLEAN Data Management Plan for more information (Appendix C).

- The project EIS, Genevieve Moore, is responsible for data tracking and storage
- Stacy Davenport of CH2M HILL's Chantilly, Virginia, office will coordinate archiving and retrieval of data

SAP Worksheet #15-1—Reference Limits and Evaluation Table

Matrix: Surface Soil

Analytical Group: Select Semivolatiles

Analyte	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference	Project Quantitation Limit Goal (mg/kg)	Laboratory-specific	
					MDLs (mg/kg)	QLs (mg/kg)
4-Methylphenol	106-44-5	0.0174	NC SSLs	0.7	0.03	0.7

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

This Project Action Limit is exceptionally low due to the NC SSL of 0.0174 mg/kg.

Per North Carolina regulations (15A NCAC 02L.0202 (b)(1)), when the regulatory standard for a particular constituent is less than the practical quantitation limit (PQL), a concentration at or above the PQL constitutes a violation of the standard.

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Matrix: Surface Soil

Analytical Group: Select Metals

Analyte	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference	Project Quantitation Limit Goal (mg/kg)	Laboratory-specific	
					MDLs (mg/kg)	QLs (mg/kg)
Lead	7439-92-1	270	NC SSLs	27	0.30	0.60

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-3—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Select Semivolatiles

Analyte	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-specific	
					MDLs (µg/L)	QLs (µg/L)
4-Methylphenol	106-44-5	3.5	NC 2L	3	1	3

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-4—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Select Metals

Analyte	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference	Project Quantitation Limit Goal (µg/L)	Laboratory-specific	
					MDLs (µg/L)	QLs (µg/L)
Lead	7439-92-1	15	NC 2L, MCL	3	1.5	3.0

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-5 - Reference Limits and Evaluation Table

Matrix: Solid IDW

Analytical Group: TCLPV (Volatile results from the leaching procedure)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
1,1-Dichloroethene	75-35-4	700	40 CFR 261.4	10	10	3.3
1,2-Dichloroethane	107-06-2	500	40 CFR 261.4	10	10	3.3
2-Butanone	78-93-3	200000	40 CFR 261.4	100	100	33
Benzene	71-43-2	500	40 CFR 261.4	10	10	3.3
Carbon tetrachloride	56-23-5	500	40 CFR 261.4	10	10	3.3
Chlorobenzene	108-90-7	100000	40 CFR 261.4	10	10	3.3
Chloroform	67-66-3	6000	40 CFR 261.4	10	10	3.3
Tetrachloroethene	127-18-4	700	40 CFR 261.4	10	10	3.3
Trichloroethene	79-01-6	500	40 CFR 261.4	10	10	3.3
Vinyl chloride	75-01-4	200	40 CFR 261.4	10	10	3.3

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-6 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: TCLPS (Semivolatile results from the leaching procedure)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
2-Methylphenol	95-48-7	200000	40 CFR 261.4	50	50	10
4-Methylphenol	106-44-5	200000	40 CFR 261.4	50	50	10
1,4-Dichlorobenzene	106-46-7	7500	40 CFR 261.4	50	50	10
2,4-Dinitrotoluene	121-14-2	130	40 CFR 261.4	50	50	10
Hexachlorobenzene	118-74-1	130	40 CFR 261.4	50	50	10
Hexachlorobutadiene	87-68-3	500	40 CFR 261.4	50	50	10
Hexachloroethane	67-72-1	3000	40 CFR 261.4	50	50	10
Nitrobenzene	98-95-3	2000	40 CFR 261.4	50	50	10
Pentachlorophenol	87-86-5	100000	40 CFR 261.4	200	200	20
Pyridine	110-86-1	5000	40 CFR 261.4	200	200	20
2,4,5-Trichlorophenol	95-95-4	400000	40 CFR 261.4	50	50	10
2,4,6-Trichlorophenol	88-06-2	2000	40 CFR 261.4	50	50	10

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-7 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: TCLPP (Pesticide and PCB results from the leaching procedure)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
gamma-BHC (Lindane)	58-89-9	400	40 CFR 261.4	0.1	0.1	0.03
Heptachlor	76-44-8	8	40 CFR 261.4	0.1	0.1	0.03
Heptachlor epoxide	1024-57-3	8	40 CFR 261.4	0.1	0.1	0.03
Endrin	72-20-8	20	40 CFR 261.4	0.1	0.1	0.03
Methoxychlor	72-43-5	10000	40 CFR 261.4	0.1	0.1	0.03
Toxaphene	8001-35-2	500	40 CFR 261.4	10	10	2.0
Chlordane (technical)	12789-03-6	30	40 CFR 261.4	0.5	0.5	0.17

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-8 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: TCLPH (Herbicide results from the leaching procedure)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
2,4,5-TP (Silvex)	93-72-1	1000	40 CFR 261.4	0.5	0.5	0.2
2,4-D	94-75-7	10000	40 CFR 261.4	5.0	5.0	2.0

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-9 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: TCLPM (Metal results from the leaching procedure)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
Arsenic	7440-38-2	5000	40 CFR 261.4	100	100	30
Barium	7440-39-3	100000	40 CFR 261.4	2000	2000	50
Cadmium	7440-43-9	1000	40 CFR 261.4	50	50	10
Chromium	7440-47-3	5000	40 CFR 261.4	100	100	20
Lead	7439-92-1	5000	40 CFR 261.4	30	30	15
Selenium	7782-49-2	1000	40 CFR 261.4	50	50	30
Silver	7440-22-4	5000	40 CFR 261.4	100	100	10
Mercury	7439-97-6	200	40 CFR 261.4	2.0	2.0	0.8

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-10 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: Reactivity (includes reactive sulfide and reactive cyanide)

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
Reactive Cyanide	REACT-CN[1]	NC	N/A	0.25	0.25	0.13
Reactive Sulfide	REACT-S[1]	NC	N/A	2.3	2.3	0.75

NC = No criteria; N/A = Not applicable

[1] Contractor-generated CAS Number.

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-11 - Reference Limits and Evaluation Table

Matrix: Liquid IDW
Analytical Group: Corrosivity

Analyte	CAS Number	Project Action Limit (ug/L)	Project Action Limit Reference	Project Quantitation Limit Goal (ug/L)	Laboratory-specific	
					QLs (ug/L)	MDLs (ug/L)
pH	PH[1]	2<pH<12.5	40 CFR 261.4	0<pH<14	N/A	N/A

NC = No criteria; N/A = Not applicable
[1] Contractor-generated CAS Number

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #15-12 - Reference Limits and Evaluation Table

Matrix: Solid IDW
Analytical Group: Ignitability

Analyte	CAS Number	Project Action Limit (°F)	Project Action Limit Reference	Project Quantitation Limit Goal (°F)	Laboratory-specific	
					QLs (°F)	MDLs (°F)
Ignitability	FLASHPOINT[1]	140	40 CFR 261.4	140	N/A	N/A

[1] Contractor-generated CAS Number

Shading represents Project Action Limits which are below Laboratory Quantitation Limits.

SAP Worksheet #16—Project Schedule / Timeline

The estimated schedule for project implementation is provided in the table below. It is important to note that the dates shown in the schedule are based on potentially variable assumptions (e.g., work plan review durations, subcontractor availability and performance, site accessibility, field progress). This schedule may require revision as the project progresses.

Estimated Project Schedule
Supplemental Site Investigation Work Plan

Deliverable	Contractor Submittal Calendar Days
Draft WP	60 days after award
Final WP	30 days after comment resolution
Draft SSI Report	30 days after receipt of validated 4th round sampling data
Final SSI Report	30 days after comment resolution
Draft CAP Report	30 days after submitting Final SSI Report
Final CAP Report	30 days after comment resolution
Draft Public Summary Notice	Submit concurrent with Final SSI Report
Final Public Summary Notice	30 days after submitting Final SSI Report

SAP Worksheet #17—Sampling Design and Rationale

The sampling design and rationale was the outcome of the May 10, 2007 meeting in which NCDENR and NAVFAC Mid-Atlantic agreed on the investigation elements outlined in this SAP. The sampling points at each site were located to confirm elevated concentrations detected from previous investigations. The proposed sampling locations are shown in Figure 5.

Soil samples will be collected from 0 to 6 inches bgs. Monitoring wells will be installed with the top of the screen interval at or near the groundwater table. During drilling for monitoring well installation, the lithology will be described to the total depth of the boring. The installation of three monitoring wells will allow for the characterization of the groundwater flow direction.

Field QC samples (consisting of trip blanks, field blanks, equipment blanks, duplicate samples, and matrix spike/matrix spike duplicate [MS/MSD] samples) will be collected during the investigation and submitted for laboratory analysis. Required QA/QC samples and the required frequency of collection are as follows:

Sample Type	Description	Frequency	Analytes
Field Blank	Designed to detect contamination in the decontamination water. A field blank is decontamination water collected directly in the sample bottle. It will be handled like a sample and transported to the laboratory for analysis.	One field blank from each source of decontamination water for each sampling event, where a sampling event is defined as a maximum of 1 week	All laboratory analyses requested for the environmental samples collected at the site for that week
Equipment Blank	Designed to detect contamination of environmental samples caused by contamination of sampling equipment. An equipment blank is certified analyte-free water that is poured into or pumped through the sampling device, transferred to a sample bottle, and transported to the laboratory for analysis.	One each day of sampling	All laboratory analyses requested for environmental samples collected at the site on that day
Field Duplicate	Designed to check precision of the overall data. A field duplicate is a sample collected in addition to the native sample at the same sampling location during the same sampling event.	10 percent: one every 10 samples	Same parameters as parent sample
MS/MSD	Designed to evaluate potential matrix interferences, accuracy, and precision. Three aliquots of a single sample—one native and two spiked with the same concentration of MS compounds—are analyzed.	5 percent: one every 20 samples	Same parameters as parent sample

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Round 1

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples[1]	Sampling SOP Reference
BT11-87MW01-MMYY BT11-87MW02-MMYY BT11-87MW03-MMYY	Groundwater	Middle of the screen	Metals	3 field samples 1 field dup.	See Worksheet 21 and Field SOPs in Appendix B.
	Groundwater	Middle of the screen	SVOCs	3 field samples 1 field dup.	
BT11-87SS03-T-B-MMYY BT11-87SS04-T-B-MMYY BT11-87SS05-T-B-MMYY BT11-87SS06-T-B-MMYY	Surface soil	0-6” bgs	Metals	4 field samples 1 field dup.	
	Surface soil	0-6” bgs	SVOCs	4 field samples 1 field dup.	
BT11-87IDW-MMDDYYYY	Solid IDW	Composite from drum	Full TCLP (VOCs, SVOCs, Pesticides, Herbicides, Metals), Reactivity, Ignitability, Corrosivity	1 field sample	

[1] The locations for field duplicate and MS/MSD sample collection will be determined in the field by the FTL.

Notes:
"T-B" - indicates the top and bottom depths in feet
MMYY - should be populated with the month and year of sample collection

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Round 2

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples[1]	Sampling SOP Reference
BT11-87MW01-MMYY BT11-87MW02-MMYY BT11-87MW03-MMYY	Groundwater	Middle of the screen	Metals	3 field samples 1 field dup.	See Worksheet 21 and Field SOPs in Appendix B.
			SVOCs	3 field samples 1 field dup.	

[1] The locations for field duplicate and MS/MSD sample collection will be determined in the field by the FTL.

Round 3

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples[1]	Sampling SOP Reference
BT11-87MW01-MMYY BT11-87MW02-MMYY BT11-87MW03-MMYY	Groundwater	Middle of the screen	Metals	3 field samples 1 field dup.	See Worksheet 21 and Field SOPs in Appendix B.
			SVOCs	3 field samples 1 field dup.	

[1] The locations for field duplicate and MS/MSD sample collection will be determined in the field by the FTL.

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Round 4

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples[1]	Sampling SOP Reference
BT11-87MW01-MMYY BT11-87MW02-MMYY BT11-87MW03-MMYY	Groundwater	Middle of the screen	Metals	3 field samples 1 field dup.	See Worksheet 21 and Field SOPs in Appendix B.
			SVOCs	3 field samples 1 field dup.	

[1] The locations for field duplicate and MS/MSD sample collection will be determined in the field by the FTL.

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Containers (Number, Size, and Type)	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)[2]
GW	SVOCs	SW-846 8270C/ SOPs 201, 300, 329	1000 mL MS/MSD: 3000 mL	2 - 1L amber-glass MS/MSD: 6 x 1L ambers	Cool 4°C	7 days / 40 days
GW	Metals	SW-846 6010B/ SOPs 100, 105	250 mL MS/MSD: 750 mL	1 - 250 mL plastic MS/MSD: 3 x 250 mL plastic	Cool 4°C HNO_3 < pH2	180 days / 180 days
SS	SVOCs	SW-846 8270C/ SOPs 201, 300, 329	120 g MS/MSD: 360 g	1-4oz glass jar MS/MSD: 3 x 4 oz. glass jars	Cool 4°C	14 days / 40 days
SS	Metals	SW-846 6010B/ SOPs 100, 105	120 g MS/MSD: 360 g	1-4oz glass jar MS/MSD: 3 x 4 oz. glass jars	Cool 4°C	180 days / 180 days
Solid	TCLPV	SW-846 1311, 8260B / SOP-198, 202	4 oz	4 oz amber glass jar	Cool 4°C	14 days / 14days
	TCLPS	SW-846 1311, 8270C / SOP-198, 201, 300, 329	100 g	8 oz amber glass jar		14 days / 7days / 40days
	TCLPP	SW-846 1311, 8081A / SOP-198, 211	100 g	8 oz amber glass jar		14 days / 7days / 40days
	TCLPH	SW-846 1311, 8151A / SOP-198, 208/304	100 g	8 oz amber glass jar		14 days / 7days / 40days
	TCLPM	SW-846 1311, 6010B, 7470A /SOP-100, 105, 198, 103	100 g	8 oz amber glass jar		28 days / 28days
	REACT	SW846 9012A /SOP-156/164/175	30 g	4 oz amber glass jar		N/A
	CORR	SW-846 9045C / SOP-187	10 g	4 oz amber glass jar		N/A
	IGN	Pensky Martens / SOP-149	50 g	4 oz amber glass jar		N/A

[1] MS/MSD samples will require triple volume. This includes volume for the parent sample, MS, and MSD.

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. (Not VTSR)

SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	Number of Sample Locations/ round	Number of Field Duplicates/ round	Number of MS/MSD pairs[1] / round	Number of Field Blanks/ round	Number of Equipment Blanks/ round	Number of VOA Trip Blanks/ round	Total Number of Samples to the Lab[2]
SS	SVOCs	4	1	1	1	1	0	7
	Metal	4	1	1	1	1	0	7
GW	SVOCs	3	1	1	1	1	0	24
	Metal	3	1	1	1	1	0	24
Solid	TCLP-Volatiles	1	0	0	0	0	0	1
	TCLP-Semivolatiles	1	0	0	0	0	0	1
	TCLP-Pesticides	1	0	0	0	0	0	1
	TCLP-Herbicides	1	0	0	0	0	0	1
	TCLP-Metals	1	0	0	0	0	0	1
	Reactivity	1	0	0	0	0	0	1
	Corrosivity	1	0	0	0	0	0	1
	Ignitability	1	0	0	0	0	0	1

[1] Each MS/MSD pair will be associated with a parent sample. Triple volume will be collected at the locations selected for MS/MSD analysis.

[2] 3 groundwater samples will be collected per quarterly event. Four quarterly events will take place. Final Number of Samples to the Lab reflects the sample count for all 4 events.

SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
BlankPrep	Equipment Blank and Field Blank Preparation, 5/20/03	CH2M HILL	Sample bottles, gloves, blank liquid, preservatives	N	
GH-1.5	Borehole and Sample Logging, 3/1/96	B&R Environmental, NE	Boring log or field notebook, indelible pen	N	SOP located in Appendix A of the *Master Field Sampling Plan* [FSP] (AQVIQ/CH2M HILL Joint Venture I, 2004)
COC	Chain-of-Custody, 5/20/03	CH2M HILL	Chain-of-Custody	N	
Decon	Decontamination of Personnel and Equipment, 5/21/03	CH2M HILL	DI water, distilled water, potable water, Liquinox, plastic pails or tubs, 55 gallon drum, gloves, decon pad	N	
DeconRig	Decontamination of Drilling Rigs and Equipment, 1/06/04	CH2M HILL	Portable steam cleaner, potable water, Liquinox, buckets, brushes, distilled water, methanol, ASTM Type-II water, aluminum foil	N	
DrumSample	Sampling Contents of Tanks and Drums, 5/21/03	CH2M HILL	Misc. applicable sampling equipment	N	
GH-1.3	Soil and Rock Drilling Methods, 3/1/96	B&R Environmental, NE	Applicable drilling rig	N	SOP located in Appendix A of the *Master Field Sampling Plan* [FSP] (AQVIQ/CH2M HILL Joint Venture I, 2004)
HoribaU22	Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature using the Horiba® U-22 with Flow-through Cell, 1/23/03	CH2M HILL	Horiba® U-22 Water Quality Checker with flow-through cells, distilled water in squirt bottle, Horiba® U-22 Auto-Calibration Standard Solution.	N	

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Log Books	Preparing Field Log Books, 5/21/03	CH2M HILL	Log book, indelible pen	N	
GH-2.8	Groundwater Monitoring Point Installation	B&R Environmental, NE	Applicable monitoring well installation equipment	N	SOP located in Appendix A of the *Master Field Sampling Plan* [FSP] (AQVIQ/CH2M HILL Joint Venture I, 2004)
Preserve	Preserving Non-VOC Aqueous Samples, 2/03/99	CH2M HILL	Disposable eye droppers, clean beakers, pH paper, chemical preservatives, personal protection, clean outdoor or vented indoor area	N	
Soils	Soil Sampling, 5/16/03	CH2M HILL	Stainless steel trowel, shovel, scoopula, coring device, trier, hand auger, etc; stainless steel split-spoon samplers, thin-walled sampling tubes, drilling rig or soil-coring rig, stainless steel pan or bowl, sample bottles	N	
Civil Surveying	Civil Surveying, 3/8/99	CH2M HILL	Applicable surveying equipment	N	SOP located in Appendix A of the *Master Field Sampling Plan* [FSP] (AQVIQ/CH2M HILL Joint Venture I, 2004)
CT-04	Sample Nomenclature, 3/1/96	B&R Environmental, NE		N	SOP located in Appendix A of the *Master Field Sampling Plan* [FSP] (AQVIQ/CH2M HILL Joint Venture I, 2004)
Utility Location General	Locating and Clearing Underground Utilities, 5/21/03	CH2M HILL	Magnetic Field Methods, Optical Methods, Ground Penetrating Radar, Electromagnetic Induction	N	

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Water Levels	Water-Level Measurements, 5/19/03	CH2M HILL	Electronic water-level meter with 100 foot tape, interface probe	N	
Homog	Homogenization of Soil and Sediment Samples, 5/20/03	CH2M HILL	Sample containers, stainless steel spoons or spatulas, stainless steel pans	N	
ShipLowConc	Packaging and Shipping Procedure for Low-Concentration Samples, 5/23/03	CH2M HILL	Packing Materials	N	
LowFlow	Low-Flow Groundwater Sampling from Monitoring Wells, 5/20/03	CH2M HILL	Flow-Through Cell	N	Samples will be collected from the middle of the well screen
HSE-408	Waste Management: Analysis and Characterization, 10/11/07	CH2M HILL	Field logbook, Chain of Custody, sample labels, custody seals	N	
HSE-411	Waste Management: Non-Hazardous Waste, 10/12/07	CH2M HILL	Container labels, waste containers,	N	

SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference	Comments
Horiba U-22 pH probe	Calibration	Daily, before use	pH reads 4.0 +/- 3%	Clean probe with Deionized water and calibrate again. Do not use instrument if not able to calibrate properly	Field Team Lead	HoribaU22	
Horiba U-22 Specific conductance probe	Calibration	Daily, before use	Conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22 Turbidity probe	Calibration	Daily, before use	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22 Dissolved oxygen and Temperature Probes	Testing	Daily, before use	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22	Maintenance- Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes. pH reads 4.0 +/- 3% conductivity reads 4.49 +/- 3% turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	

SAP Worksheet #23—Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
SOP-100	Metals digestion for ICP Analysis, 4/10/08, rev.19	Definitive	Metals	Hot block	Empirical Laboratories	N
SOP-105	Metals analysis by ICP, 4/10/08, rev.13	Definitive	Metals	ICP 61E		N
SOP-201	GC/MS analysis by 8270C, 1/11/08, rev.17	Definitive	Organics	Agilent GC/MS		N
SOP-300	Sample extraction - aqueous samples for 8270 analysis, 7/03/07, rev.15	Definitive	Extractions	N/A		N
SOP-329	Sample extraction – non-aqueous samples by automated Soxhlet, 10/04/06, rev.14	Definitive	Extractions	Soxtherm		N
SOP-404	Laboratory Sample Receiving, Log in, and Storage, 7/20/06, rev.10	Definitive	Sample receipt	n/a		N
SOP-410	Laboratory Sample Storage, Secure Areas, and Sample Custody, 2/10/06, rev.4	Definitive	Sample Custody	n/a		N
SOP-149	Flashpoint Ignitability Method SW846 1010, Rev. 1	Definitive	Wet Chem	Flashpoint Tester		N
SOP-153	Sulfide Method 376.1 (Titrimetric, Iodine) with Sample Pretreatment to Remove Interfering Substances or to Concentrate Sulfide, Rev. 2	Definitive	Wet Chem	NA		N
SOP-156	Reactive Sulfide Method SW-846, Chapter7, Section 7.3.4, Rev. 3	Definitive	Wet Chem	NA		N
SOP-164	Distillation of Aqueous/Solid Samples for Total and Non-Amenable Cyanide Analysis Methods 335.1/335.4 SW846 9012A/ USEPA CLP ILMO 4.1, Rev. 12	Definitive	Wet Chem	NA		N
SOP-175	Post-Distillation Analysis for Cyanide by the LACHAT Methods 335.4; SW846 9012A; USEPA-CLP 4.1; Addendum for USEPA CLP ILM 5.2 Aqueous & Soil/Sediment, Rev.9	Definitive	Wet Chem	LACHAT		N

SAP Worksheet #23—Analytical SOP References Table (continued)

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
SOP-187	Electrometric Determination of pH, Methods 150.1, Standard Methods 4500-H+B and 9040B for Waters , Liquids, and Liquid Wastes, 9045C for Soils and Solid Wastes, Rev.6	Definitive	Wet Chem	pH Meter	Empirical Laboratories	N
SOP-198	Toxicity Characteristic Leaching Procedure Method 1311), Rev.5	Definitive	Wet Chem	NA		N
SOP-202	GC/MS Volatiles by Method 624 and SW 846 Method 8260B, Rev. 20	Definitive	VOAs	GC/MS		N
SOP-208	GC/ECD Chlorinated Acid Herbicides by SW846 Method 8150B/8151A, Rev.12	Definitive	Herbs	GC/ECD		N
SOP-211	GC/ECD Organochlorine Pesticides/PCBs by EPA Method 608 and SW846 Method 8081A/8082, Rev.18	Definitive	Pest/PCBs	GC/ECD		N
SOP-304	Herbicides Aqueous Matrix by Methods EPA SW846 8151A, Rev.9	Definitive	Herbs Ext.	NA		N
SOP-103	Mercury Analysis in Water by Manual Cold Vapor Technique Methods USEPA SW846 7470A & 245.1 CLP-M 4.1, Rev. 13	Definitive	Metals	Hg Analyzer		N

SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
SVOC GC/MS	Initial Calibration	Instrument receipt, instrument change (new column, source cleaning, etc.), when CCV does not meet criteria, prior to sample analysis	• Min. 5 pt cal. • RSD for 4-methylphenol CCC <30%. • Minimum mean RF for 4-methylphenol SPCC ≥ 0.05 • If RSD for 4-methylphenol is >15% apply linear (r2>0.995) or quadratic (r2>0.99, min. 6 pts) method for quantitation.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/Supervisor	Empirical SOP 201
SVOC GC/MS	Calibration Check	At the beginning of each 12 hr shift after DFTPP tune.	• Minimum mean RF for 4-methylphenol SPCC ≥ 0.05 • ≤20% difference for 4-methyphenol CCC.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Analyst/Supervisor	Empirical SOP 201
ICP Metals	Initial Calibration	At the beginning of each day or if QC is out of criteria.	• One point calibration per manufacturer's guidelines. • Lead run at its calibration levels must fall within 90-110% of True Values.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst/Supervisor	Empirical SOP 105
ICP Metals	Continuing Calibration	At the beginning and end of sequence and after every 10 samples.	• Lead must be within 90-110% of true value.	Recalibrate and/or perform necessary equipment maintenance. Reanalyze samples not bracketed by passing CCVs.	Analyst/Supervisor	Empirical SOP 105
VOC GC/MS	Minimum five point calibration for all analytes	Prior to sample analysis or instrument change, when instrument does not meet method criteria	• 30% RSD for CCC's and Min RF for SPCCs, 15% for Avg RF, 0.995 corr for linear, 0.99 corr for Quadratic	Recalibrate and or perform necessary instrument maintenance, Check calibration standards, Reanalyze affected samples	Analyst/Supervisor	Empirical SOP 202
PEST/HERB GC/ECD	Minimum five point calibration for all analytes	Prior to sample analysis or instrument change, when instrument does not meet method criteria	• 20%RSD, Min. Corr. 0.995 Linear, 0.99 Quadratic	Recalibrate and or perform necessary instrument maintenance, Check calibration standards, Reanalyze affected samples	Analyst/Supervisor	Empirical SOP-211/208

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
pH Meter	Calibrate meter at pH 7 and 4, check 7 again and pH 10	Before analysis and check every 3 hrs	• 4 and 7 + .05 pH units, pH 10 + 0.10 pH units, + 0.20 pH units for check	Recalibrate as necessary	Analyst/Supervisor	Empirical SOP 187
LACHAT	Minimum five point calibration	At the beginning of each day or if QC is outside criteria	• Correlation coefficient >0.997	Recalibrate and or perform necessary instrument maintenance, Check calibration standards, Reanalyze affected samples	Analyst/Supervisor	Empirical SOP 175
Hg Analyzer/FIMS	Minimum five point calibration	At the beginning of each day or if QC is outside criteria	• Correlation coefficient >0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	Empirical SOP 103
Flashpoint Tester	Flashpoint of p-xylene	At the beginning and end of each set of 20 samples or less	• Flash at 27 degrees C, + 2.2 degrees C	Check standard	Analyst/Supervisor	Empirical SOP 149

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
SVOC, VOC GC/MS	Check pressure and gas supply daily. Bake out column, manual tune if DFTPP not in criteria, change septa, liner, seal as needed, cut column as needed.	QC Standards	Ion source, liner, seal, septum, column	Prior to initial calibration or as necessary	30% RSD CCCs, min RF SPCCs, 15% Avg RSD, 0.995 linear, 0.99 corr. Quadratic init cal; 20% diff CCV for CCCs, min RF SPCCs	Recalibrate and or perform necessary instrument maintenance, Check calibration standards, Reanalyze affected samples	Analyst/ Supervisor	Empirical SOP 201, 202
ICP Metals	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, replace peristaltic pump tubing as needed.	QC Standards	Torch, nebulizer chamber, pump, tubing	Prior to initial calibration or as necessary	90-110% of true value	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/ Supervisor	Empirical SOP 100/105
GC/ECD	Check gas supply daily, Change liner, septum, seal. Cut column as needed	Pest/Herb Analysis	Seal, septum, liner	Prior to sample analysis or instrument change, when instrument does not meet method criteria	20%RSD, Min. Corr. 0.995 Linear, 0.99 Quadratic	Recalibrate and or perform necessary instrument maintenance, Check calibration standards, Reanalyze affected samples	Analyst/ Supervisor	Empirical SOP 208, 211
pH meter	Change buffer solutions or pH probe	Alkalinity	Calibration	Before analysis begins, check every 3 hrs	4 and 7 + .05 pH units, pH 10 + 0.10 pH units, + 0.20 pH units for check	Recalibrate as necessary	Analyst/ Supervisor	Empirical SOP 187
LACHAT	Degas solutions, change tubing, lamp, clean connectors	Cyanide	Tubing, rollers	At the beginning of each day or when QC is outside criteria	Correlation coefficient >0.997	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/ Supervisor	Empirical SOP 175

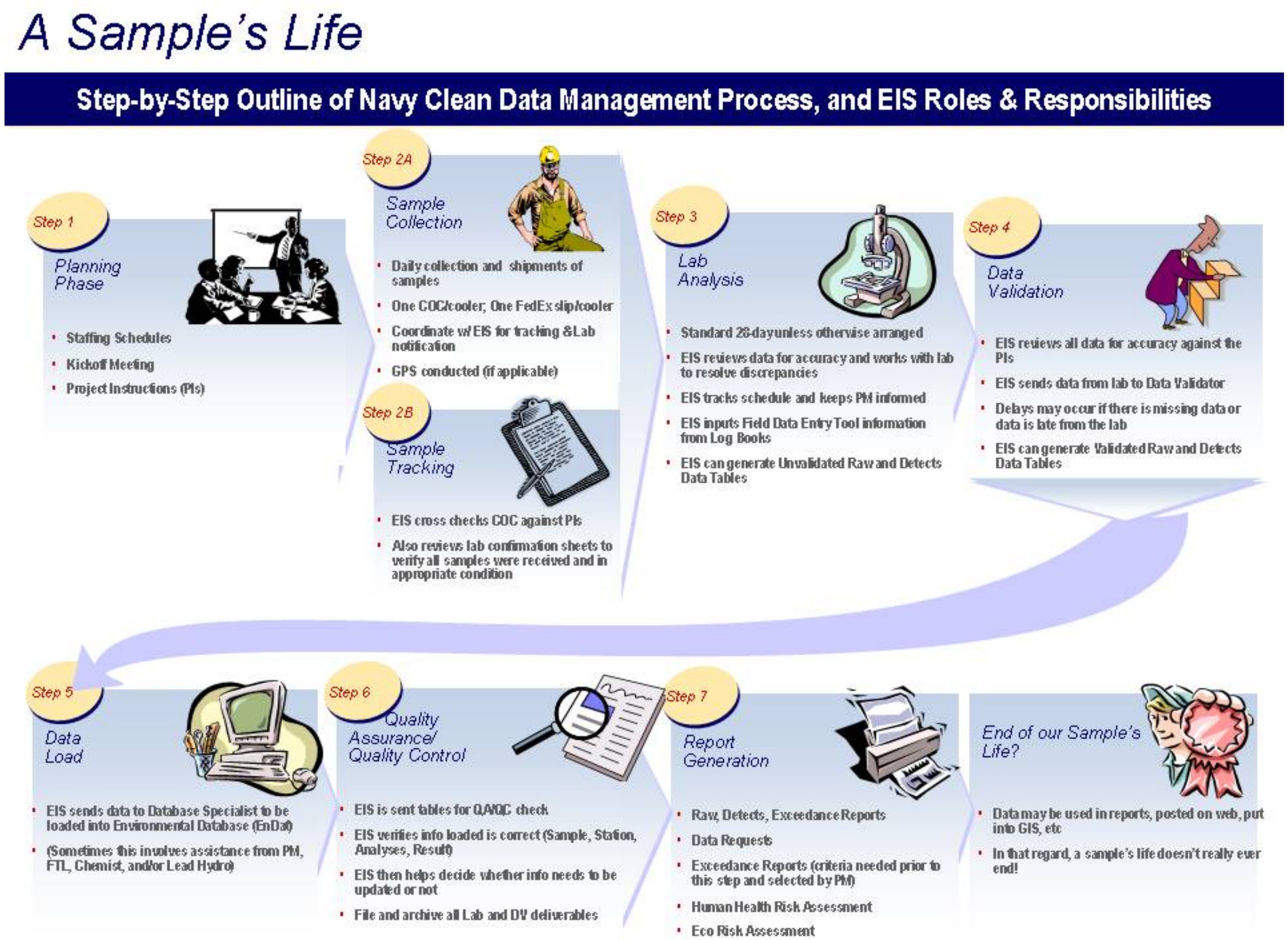
SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Hg Analyzer	Change tubing, change filter, clean windows, check gas flow, Check reagents and standards	Hg Analysis	Change tubing, change filter, clean windows, check gas flow, Check reagents and standards	At the beginning of each day or when QC is outside criteria	Correlation coefficient >0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/Supervisor	Empirical SOP 103
Flashpoint Tester	Change propane tank, calibrate thermometer	Flashpoint	Tank, thermometer	Before use	Flash at 27 degrees C, + 2.2 degrees C	Check standard	Analyst/Supervisor	Empirical SOP 149

SAP Worksheet #26-1—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Project Field Team, FTL/CH2M HILL. Field SOPs are in Appendix B of this SAP.
Sample Packaging (Personnel/Organization): Project Field Team, FTL/CH2M HILL. Field SOPs are in Appendix B of this SAP.
Coordination of Shipment (Personnel/Organization): FTL/CH2M HILL
Type of Shipment/Carrier: FedEx Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): EJ Overby, Empirical Laboratories
Sample Custody and Storage (Personnel/Organization): EJ Overby, Empirical Laboratories
Sample Preparation (Personnel/Organization): Christy Thompson (SVOCs), Roger Burr (Metals), Empirical Laboratories; others TBD
Sample Determinative Analysis (Personnel/Organization): Antonio Monteiro (SVOCs), Roger Burr (Metals), Empirical Laboratories; others TBD
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 1 year
Biological Sample Storage (No. of days from sample collection): n/a
SAMPLE DISPOSAL
Personnel/Organization: EJ Overby, Empirical Laboratories
Number of Days from Analysis: After submission, the laboratory will keep samples 90 days and the sample extracts for a minimum of 60 days

SAP Worksheet #26-2—Sample Handling Flow Diagram, Navy CLEAN Data Management Process



SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Samples will be collected by field team members under the supervision of the field team leader. As samples are collected, they will be places into containers and labeled. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples 4 +/- 2 degrees Celsius until they are received by the laboratory. The chain of custody will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, with the air bill number indicated on the COC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M HILL. See Worksheet 21 for SOPs containing sample custody guidance.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): Laboratory custody procedures can be found in the following SOPs, which are referenced in Worksheet 23 and can be found in Appendix A of this QAPP: **Empirical Labs: 404 and 410**
Sample Identification Procedures: Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, preservation, analysis group or method, and sampler's initials. Aqueous lead samples' labels should indicate HNO_3 preservation. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to the EIS to check that sample IDs and parameters are correct.
Chain-of-custody Procedures: Chain of custodies will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID. Date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain of custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

SAP Worksheet #28-1— Laboratory QC Samples Table

Matrix	Surface Soil
Analytical Group	Semivolatiles (4-Methylphenol)
Analytical Method/SOP Reference	SW-846 8270C/ SOP-201

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One every 12 hours prior to sample analysis.	4-Methylphenol concentration ≥ 1/2 CRQL	Reclean, retest, re-extract, reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor	Bias / Contamination	4-Methylphenol concentration ≥ 1/2 CRQL
Surrogates	3 per sample, all samples	Surrogates within: 2-Fluorobiphenyl: 45-105% Terphenyl-d14: 30-125% 2,4,6-Tribromophenol: 35-125% 2-Fluorophenol: 35-105% Phenol-d5/d6: 40-100% Nitrobenzene-d5: 35-100%	(1) Reprep and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor	Accuracy / Bias	Surrogates within: 2-Fluorobiphenyl: 45-105% Terphenyl-d14: 30-125% 2,4,6-Tribromophenol: 35-125% 2-Fluorophenol: 35-105% Phenol-d5/d6: 40-100% Nitrobenzene-d5: 35-100%
Laboratory Control Spike	One per batch of 20 or less	% recovery for 4-methylphenol should be 40-105%	(1) Evaluate and reanalyze if possible; (2) If an MS/MSD was performed in the same 12 hour clock and acceptable narrate; (3) If the LCS recoveries are high but the sample results are <QL narrate otherwise reprep and reanalyze.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	% recovery for 4-methylphenol should be 40-105%
Internal Standards	3 per sample	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.	Inspect mass spectrometer or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.
Matrix Spike/Matrix Spike Duplicate	One per SDG or every 20 samples	% recovery for 4-methylphenol should be 40-105% ≤30% RPD.	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met; (2) If both the LCS and MS/MSD are unacceptable reprep the samples and QC.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	% recovery for 4-methylphenol should be 40-105%

LCS = Laboratory Control Sample
CRQL = Contract Required Quantitation Limit
RL = Reporting Limit

SAP Worksheet #28-2—QC Samples Table

Matrix	Surface Soil					
Analytical Group	Metals (Lead)					
Analytical Method/SOP Reference	SW-846 6010B/ SOP-105					
QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	One per digestion batch of 20 or fewer samples.	Lead concentration less than 1/2 PQL.	(1) Investigate source of contamination. (2) Redigest and reanalyze all associated samples if sample concentration ≥QL and <10x the blank concentration.	Laboratory Supervisor	Bias / Contamination	Lead concentration less than 1/2 PQL.
Instrument Blanks(ICB, CCB)	At the beginning and end of the sequence and every 10 samples.	< 2x MDL	(1) Investigate source of contamination. (2) Re-prepare and reanalyze all associated samples if sample concentration ≥QL and <10x the blank concentration	Laboratory Supervisor	Bias / Contamination	< 2x MDL
Reporting Limit Standard(RL)	At the beginning of the sequence	± 20%	Re-prepare RL standard or recalibrate	Laboratory Supervisor	Accuracy / Bias	± 20%
Interference Checks(ICSA and ICSAB standards	At the beginning of the sequence	(1)ICSA- absolute value of concentration for all non-spiked analytes < 2xMDL(2) ICSAB- Target analytes within ± 20%	Re-prepare standards or recalibrate	Laboratory Supervisor	Accuracy / Bias	(1)ICSA- absolute value of concentration for all non-spiked analytes < 2xMDL(2) ICSAB-Target analytes within ± 20%
Laboratory Control Sample	One per digestion batch of 20 or fewer samples.	Recovery within ±20% of true value	(1) Investigate source of problem. (2) Redigest and reanalyze all associated samples.	Laboratory Supervisor	Accuracy / Bias / Contamination	Recovery within ±20% of true value
Duplicate Sample	One per digestion batch of 20 or fewer samples.	RPD ≤20% for duplicate spikes.	Qualify results	Analyst, Laboratory Supervisor	Precision	RPD ≤20% for duplicate spikes.
Matrix Spike	One per digestion batch of 20 or fewer samples.	Recover ±25% of true value, if sample <4x spike added.	Qualify results	Analyst, Laboratory Supervisor	Accuracy / Bias	Recover ±25% of true value, if sample <4x spike added.
ICP Serial Dilution	One per digestion batch.	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result.	Qualify result or dilute and reanalyzed sample to eliminate interference.	Analyst, Laboratory Supervisor	Accuracy / Bias	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result.

RPD = Relative Percent Difference
IDL = Instrument Detection Limit

SAP Worksheet #28-3—QC Samples Table

Matrix	Groundwater					
Analytical Group	Semivolatiles (4-Methylphenol)					
Analytical Method/SOP Reference	SW-846 8270C/ SOP-201					
QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	One every 12 hours prior to sample analysis.	4-Methylphenol concentration ≥ 1/2 CRQL	Reclean, retest, re-extract, reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor	Bias / Contamination	4-Methylphenol concentration ≥ 1/2 CRQL
Surrogates	3 per sample, all samples	Surrogate limits: 2-Fluorobiphenyl: 50-110% Terphenyl-d14: 50-135% 2,4,6-Tribromophenol: 40-125% 2-Fluorophenol: 20-110% Nitrobenzene-d5: 40-110%	(1) Reprep and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor	Accuracy / Bias	2-Fluorobiphenyl: 50-110% Terphenyl-d14: 50-135% 2,4,6-Tribromophenol: 40-125% 2-Fluorophenol: 20-110% Nitrobenzene-d5: 40-110%
Laboratory Control Spike	One per batch of 20 or less	4-methylphenol %recovery should be 30-110%	(1) Evaluate and reanalyze if possible; (2) If an MS/MSD was performed in the same 12 hour clock and acceptable narrate; (3) If the LCS recoveries are high but the sample results are <QL narrate otherwise reprep and reanalyze.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	4-methylphenol %recovery should be 30-110%
Internal Standards	3 per sample	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.	Inspect mass spectrometer or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	Retention time ±30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS.
Matrix Spike/Matrix Spike Duplicate	One per SDG or every 20 samples	4-methylphenol %recovery should be 30-110%	(1) CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met; (2) If both the LCS and MS/MSD are unacceptable reprep the samples and QC.	Analyst, Laboratory Supervisor	Precision / Accuracy / Bias	4-methylphenol %recovery should be 30-110%

MS = Matrix Spike
MSD = Matrix Spike Duplicate
LCS = Laboratory Control Sample

SAP Worksheet #28-4—QC Samples Table

Matrix	Groundwater					
Analytical Group	Total Metals (Lead)					
Analytical Method/SOP Reference	SW-846 6010B/SOP-105					
QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	One per digestion batch of 20 or fewer samples.	Lead concentration less than 1/2 PQL.	(1) Investigate source of contamination. (2) Redigest and reanalyze all associated samples if sample concentration ≥QL and <10x the blank concentration.	Laboratory Supervisor	Bias / Contamination	Lead concentration less than 1/2 PQL.
Instrument Blanks(ICB, CCB)	At the beginning and end of the sequence and every 10 samples.	< 2x MDL	(1) Investigate source of contamination. (2) Re-prepare and reanalyze all associated samples if sample concentration ≥QL and <10x the blank concentration	Laboratory Supervisor	Bias / Contamination	< 2x MDL
Reporting Limit Standard(RL)	At the beginning of the sequence	± 20%	Re-prepare RL standard or recalibrate	Laboratory Supervisor	Accuracy / Bias	± 20%
Interference Checks(ICSA and ICSAB standards	At the beginning of the sequence	(1)ICSA- absolute value of concentration for all non-spiked analytes < 2xMDL(2) ICSAB- Target analytes within ± 20%	Re-prepare standards or recalibrate	Laboratory Supervisor	Accuracy / Bias	(1)ICSA- absolute value of concentration for all non-spiked analytes < 2xMDL(2) ICSAB-Target analytes within ± 20%
Laboratory Control Sample	One per digestion batch of 20 or fewer samples.	Recovery within ±20% of true value	(1) Investigate source of problem. (2) Redigest and reanalyze all associated samples.	Laboratory Supervisor	Accuracy / Bias / Contamination	Recovery within ±20% of true value
Duplicate Sample	One per digestion batch of 20 or fewer samples.	RPD ≤20% for duplicate spikes.	Qualify results	Analyst, Laboratory Supervisor	Precision	RPD ≤20% for duplicate spikes.
Matrix Spike	One per digestion batch of 20 or fewer samples.	Recover ±25% of true value, if sample <4x spike added.	Qualify results	Analyst, Laboratory Supervisor	Accuracy / Bias	Recover ±25% of true value, if sample <4x spike added.
ICP Serial Dilution	One per digestion batch.	If original sample result is at least 50 x IDL, 5-fold dilution must agree within ± 10% of the original result.	Qualify result or dilute and reanalyzed sample to eliminate interference.	Analyst, Laboratory Supervisor	Accuracy / Bias	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result.

IDL = Instrument Detection Limit
RPD = Relative Percent Difference

SAP Worksheet #28-5 - QC Samples Table

Matrix:	Solid
Analytical Group:	TCLP-VOCs
Analytical Method / SOP Reference:	SW-846 1311, 8260B / SOP-198, 202

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	Every 12 hours	No target analytes > Quantitation Limit	Re-clean and re-analyze	Laboratory Supervisor	Bias / Contamination	No target analytes > Quantitation Limit
Surrogates	Each sample	surrogates within: 4-bromofluorobenzene: 85-120% Toluene-d8: 85-115% 1,2-Dichloroethane-d4: 80-135% Dibromofluoromethane: 85-120%	Check instrument performance, re-analyze and qualify data	Laboratory Supervisor	Accuracy / Bias	surrogates within: 4-bromofluorobenzene: 85-120% Toluene-d8: 85-115% 1,2-Dichloroethane-d4: 80-135% Dibromofluoromethane: 85-120%
Laboratory Control Sample	1 per batch or 1 per 20 samples	Benzene: 80-120% Carbon tetrachloride: 65-140% Chlorobenzene: 80-120% Chloroform: 65-135% 1,4-Dichlorobenzene: 75-125% 1,2-Dichloroethane: 70-130% 1,1-Dichloroethene: 70-130% 2-Butanone: 30-150% Tetrachloroethene: 45-150% Trichloroethene: 70-125% Vinyl Chloride:50-145%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	Benzene: 80-120% Carbon tetrachloride: 65-140% Chlorobenzene: 80-120% Chloroform: 65-135% 1,4-Dichlorobenzene: 75-125% 1,2-Dichloroethane: 70-130% 1,1-Dichloroethene: 70-130% 2-Butanone: 30-150% Tetrachloroethene: 45-150% Trichloroethene: 70-125% Vinyl Chloride:50-145%
Laboratory Control Sample Duplicate	1 per batch or 1 per 20 samples if no MS/MSD	RPD ≤ 30%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	RPD ≤ 30%
Internal Standards	Each sample	Area counts –50% to +100% of Initial Calibration IS or Continuing Calibration IS area counts; Retention times +/- 30 secs of Continuing Calibration	Check instrument performance, reanalyze and qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Area counts –50% to +100% of Initial Calibration IS or Continuing Calibration IS area counts; Retention times +/- 30 secs of Continuing Calibration
Matrix spike/ Matrix spike duplicate	Every 20 samples	Acceptance criteria from LCS/ LCSD	Check instrument performance, qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Acceptance criteria from LCS/ LCSD

SAP Worksheet #28-6 - QC Samples Table

Matrix:	Solid
Analytical Group:	TCLP-SVOCs
Analytical Method / SOP Reference:	SW-846 1311, 8270C / SOP-198, 201

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch or 1 per 20 samples	No target analytes > Quantitation Limit	Re-clean and re-analyze	Laboratory Supervisor	Bias / Contamination	No target analytes > Quantitation Limit
Surrogates	Each sample	Surrogates within: 2-Fluorobiphenyl: 35-110% Terphenyl-d14: 55-120% 2,4,6-Tribromophenol: 45-125% 2-Fluorophenol: 15-110% Phenol-d5/d6: 15-110% Nitrobenzene-d5: 30-110%	Check instrument performance, re-analyze and qualify data	Laboratory Supervisor	Accuracy / Bias	Surrogates within: 2-Fluorobiphenyl: 35-110% Terphenyl-d14: 55-120% 2,4,6-Tribromophenol: 45-125% 2-Fluorophenol: 15-110% Phenol-d5/d6: 15-110% Nitrobenzene-d5: 30-110%
Laboratory Control Sample	1 per batch or 1 per 20 samples	2-methylphenol: 40-110% 4-methylphenol: 30-110% 2,4-Dinitrotoluene: 50-120% Hexachlorobenzene: 50-110% Hexachlorobutadiene: 25-105% Hexachloroethane: 30-95% Nitrobenzene: 45-110% Pentachlorophenol: 40-115% Pyridine: 25-120% 2,4,5-Trichlorphenol: 50-110% 2,4,6-Trichlorophenol: 50-115%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	2-methylphenol: 40-110% 4-methylphenol: 30-110% 2,4-Dinitrotoluene: 50-120% Hexachlorobenzene: 50-110% Hexachlorobutadiene: 25-105% Hexachloroethane: 30-95% Nitrobenzene: 45-110% Pentachlorophenol: 40-115% Pyridine: 25-120% 2,4,5-Trichlorphenol: 50-110% 2,4,6-Trichlorophenol: 50-115%
Laboratory Control Sample Duplicate	1 per batch or 1 per 20 samples if no MS/MSD	RPD ≤ 30%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	RPD ≤ 30%
Internal Standards	Each sample	Area counts –50% to +100% of Initial Calibration IS or Continuing Calibration IS area counts; Retention times +/- 30 secs of Continuing Calibration	Check instrument performance, reanalyze and qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Area counts –50% to +100% of Initial Calibration IS or Continuing Calibration IS area counts; Retention times +/- 30 secs of Continuing Calibration
Matrix spike/ Matrix spike duplicate	Every 20 samples	Acceptance criteria from LCS/ LCSD	Check instrument performance, qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Acceptance criteria from LCS/ LCSD

SAP Worksheet #28-7 - QC Samples Table

Matrix:	Solid
Analytical Group:	TCLP-Pesticides
Analytical Method / SOP Reference:	SW-846 1311, 8081A / SOP-198, 211

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch or 1 per 20 samples	No target analytes > Quantitation Limit	Re-clean and re-analyze	Laboratory Supervisor	Bias / Contamination	No target analytes > Quantitation Limit
Surrogates	Each sample	surrogates within: Decachlorobiphenyl: 25-130% TCMX: 25-120%	Check instrument performance, reanalyze, qualify data	Laboratory Supervisor	Accuracy / Bias	surrogates within: Decachlorobiphenyl: 25-130% TCMX: 25-120%
Laboratory Control Sample	1 per batch or 1 per 20 samples	Endrin: 55-135% Heptachlor: 40-130% Heptachlor epoxide: 60-130% Gamma-BHC: 25-135% Methoxychlor: 55-150% Chlordane: 45-119% Toxaphene: 41-126%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	Endrin: 55-135% Heptachlor: 40-130% Heptachlor epoxide: 60-130% Gamma-BHC: 25-135% Methoxychlor: 55-150% Chlordane: 45-119% Toxaphene: 41-126%
Laboratory Control Sample Duplicate	1 per batch or 1 per 20 samples if no MS/MSD	RPD ≤ 30%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	RPD ≤ 30%
Matrix spike / Matrix spike duplicate	Every 20 samples	Use acceptance criteria from LCS/LCSD	Check instrument performance, qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Use acceptance criteria from LCS/LCSD

SAP Worksheet #28-8 - QC Samples Table

Matrix:	Solid
Analytical Group:	TCLP-Metals
Analytical Method / SOP Reference:	SW-846 1311, 6010B, 7470A / SOP-198, 103, 105

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch or 1 per 20 samples	No target analytes > Quantitation Limit	Re-digest and reanalyze	Laboratory Supervisor	Bias / Contamination	No target analytes > Quantitation Limit
Laboratory Control Sample	1 per batch or 1 per 20 samples	%Recovery 80% - 120%	Re-digest and reanalyze	Laboratory Supervisor	Accuracy / Bias / Contamination	%Recovery 80% - 120%
Duplicate Sample	1 per 20 samples	RPD <=20%	Qualify Data	Laboratory Supervisor	Precision	RPD <=20%
Matrix Spike	1 per 20 samples	RPD <=20% %Recovery 80% - 120%	Perform post-digestion spike analysis, qualify data	Laboratory Supervisor	Accuracy / Bias	RPD <=20% %Recovery 80% - 120%
Post-digestion Spike	For compounds outside of QC limits in Matrix Spike	Must meet acceptance criteria presented in SOP 103, 105	Qualify data	Laboratory Supervisor	Accuracy / Bias	Must meet acceptance criteria presented in SOP 103, 105
ICP Serial Dilution	Per analytical run	%Difference 90% - 110%	Qualify data	Laboratory Supervisor	Accuracy / Bias	%Difference 90% - 110%

SAP Worksheet #28-9 - QC Samples Table

Matrix:	Solid
Analytical Group:	TCLP-Herbicides
Analytical Method / SOP Reference:	SW-846 1311, 8151A / SOP-198, 208

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch or 1 per 20 samples	No target analytes > Quantitation Limit	Re-clean and re-analyze	Laboratory Supervisor	Bias / Contamination	No target analytes > Quantitation Limit
Surrogates	Each sample	Surrogates within: DCAA: 20-140%	Check instrument performance, reanalyze, qualify data	Laboratory Supervisor	Accuracy / Bias	Surrogates within: DCAA: 20-140%
Laboratory Control Sample	1 per batch or 1 per 20 samples	2,4-D: 35-115% 2,4,5-TP: 50-115%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	2,4-D: 35-115% 2,4,5-TP: 50-115%
Laboratory Control Sample Duplicate	1 per batch or 1 per 20 samples if no MS/MSD	RPD ≤ 30%	Check instrument performance, reanalyze	Laboratory Supervisor	Accuracy / Bias	RPD ≤ 30%
Matrix spike / Matrix spike duplicate	Every 20 samples	Use acceptance criteria from LCS/LCSD.	Check instrument performance, qualify data	Laboratory Supervisor	Precision / Accuracy / Bias	Use acceptance criteria from LCS/LCSD.

SAP Worksheet #28-10 - QC Samples Table

Matrix:	Solid
Analytical Group:	Reactivity
Analytical Method / SOP Reference:	SW846 9012A / SOP-156

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per batch	No target analytes > Quantitation Limit	Re-clean and re-analyze	Laboratory Supervisor	Bias/Contamination	No target analytes > Quantitation Limit
Lab Control Sample/ Lab Control Sample Duplicate	One per batch of 20 or fewer samples (include LCSD if no MSD in batch)	Reactive sulfide = %Recovery 22% - 114%, Reactive cyanide = %Recovery 0% - 12.4%	Recalibrate/reanalyze	Laboratory Supervisor	Accuracy, Precision	Reactive sulfide = %Recovery 22% - 114%, Reactive cyanide = %Recovery 0% - 12.4%

SAP Worksheet #28-11 - QC Samples Table

Matrix:	Solid
Analytical Group:	Corrosivity
Analytical Method / SOP Reference:	SW-846 9045 / SOP-187

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Lab control sample (pH 7.0 buffer)	Every 10 samples	+/- 0.05 pH units	Recalibrate/reanalyze	Laboratory Supervisor	Accuracy, Precision	+/- 0.05 pH units
Duplicate	One set per 20 field samples	Relative Percent Difference <=20%	Qualify Data	Laboratory Supervisor	Precision	Relative Percent Difference <=20%

SAP Worksheet #28-12 - QC Samples Table

Matrix:	Aqueous
Analytical Group:	Ignitability
Analytical Method / SOP Reference:	SW-8436 1010 / SOP-149

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Lab Control Sample	One per batch of 20 or fewer samples	%Recovery 80% - 120%	Reanalyze	Laboratory Supervisor	Accuracy	%Recovery 80% - 120%
Duplicate	One set per 20 field samples, for every sample that flashes, or extinguishes flame <140 degrees	Relative Percent Difference <=20%	Repeat, Qualify Data	Laboratory Supervisor	Precision	Relative Percent Difference <=20%

SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • Corrective Action Forms • Electronic Data Deliverables • Identification of QC Samples • IWTP Disposal Chit (for IDW water) • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes and soil boring/drilling logs • Soil disposal manifests, weigh tickets, and landfill receipts (for non-haz waste) or certificate of disposal (if haz waste) • Well construction records • Water quality parameters. • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • Corrective Action Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk) • Fixed Laboratory Audit Checklists • Data Validation Reports • Corrective Action Forms • Laboratory QA Plan • MDL Study Information	• Field data deliverables such as logbooks entries, chain of custodies, air bills, EDDs, etc will be kept on CH2M HILL's local internet server. • Field parameter data will be loaded with the analytical data into EnDat • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. • Electronic data from the laboratory will be loaded into EnDat and Navy Installation Restoration Information Server NIRIS

SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
GW	SVOCs	Low	See Worksheet 18	SW846 8270C	28 days	Empirical Laboratories, LLC, 227 French Landing Drive, Nashville, TN 37228, Marcia McGinnity, 877-345-1113, ext. 232.	TBD[1]
	Metals	Medium		SW846 6010B			
SS	SVOCs	Low		SW846 8270C			
	Metals	Medium		SW846 6010B			
Solid	TCLP-VOCs	Medium		SW846 1311/ 8260B			
	TCLP-SVOCs			SW846 1311/ 8270C			
	TCLP-Pesticides			SW846 1311/ 8081A			
	TCLP-Herbicides			SW846 1311/ 8151A			
	TCLP-Metals			SW846 1311/ 6010B			
	Reactivity			SW846 9012A			
	Corrosivity			SW846 9045C			
	Ignitability			Pensky Martens			

All samples will be delivered to the off-site analytical laboratory, Empirical Laboratories.

[1] To be determined. If circumstances arise that render Empirical unable to provide analytical services, a backup laboratory will be chosen at that time.

SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)	Person(s) Responsible for Monitoring Effectiveness of CA
Offsite Laboratory Technical Systems Audit	Laboratory must have current Naval Facilities Engineering Service Center (NFESC) evaluation letter which will identify the period of performance. The laboratory must be re-evaluated prior to expiration of period of performance.	External	U.S. Navy (NFESC)	Project QA Officer- Pati Moreno/ NFESC, Port Hueneme, CA	Laboratory's QA Officer	Laboratory's QA Officer	Program Chemist- Anita Dodson- CH2M HILL

An onsite field sampling technical systems audit will not be performed on this project due to the brevity of the field event.

SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Laboratory Performance and Systems Audits	Written Audit Report	Laboratory QA Manager	Within 2 months of audit	Memorandum	NFESC Auditor, TBD	Within 2 months of receipt of initial notification.

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Site Investigation Report (Addendum)	Post- Field Event	TBD	Laura Lampshire, Project Manager, CH2M HILL	Stakeholders, see Worksheet 4

The SI Report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project to UFP-SAP requirements/procedures
- Status of project schedule
- Deviations from the UFP-SAP and approved amendments that were made
- Results of data review activities (how much usable data was generated)
- Corrective actions if needed and their effectiveness
- Data usability with regards to: precision, accuracy, representativeness, completeness, comparability, and sensitivity
- Limitations on data use

SAP Worksheet #34—Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	Laura Lampshire CH2M HILL
Chain of Custody and shipping forms	COC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC will be initialed by the reviewer, a copy of the COC retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See COC SOP (on CD) for further details.	Internal	FTL and Genevieve Moore CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	Laura Lampshire CH2M HILL
Sample Chain of Custody Documentation	Upon their arrival at the laboratory, the samples will be cross-referenced against the COC records. All sample labels will be checked against the COC, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	EJ Overby Empirical Laboratories
Verification of Laboratory Data Package	Upon receipt of the laboratory data package, the EIS will perform data check according to the procedures in Worksheet 14.	External	Genevieve Moore CH2M HILL
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	Genevieve Moore CH2M HILL
Field Investigation Interpretive Data	Following receipt of the analytical data from the laboratory and prior to submittal to the data validator, the data will be compared to screening criteria (see Worksheet 15)..	Internal	Laura Lampshire, Roni Warren, Bill Kappleman CH2M HILL

SAP Worksheet #35—Validation (Steps IIa and IIb) Process Table

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	**FTL, Laura Lampshire** *CH2M HILL*
IIa	QC Results	Establish that all QC samples were run and compliant with method-required limits as specified in Worksheet 12.	**Nancy Weaver** *Environmental Data Services*
IIb	QC Results	Verify that QC samples were run and compliant with limits established in the UFP-SAP.	**Megan Hilton** *CH2M HILL* **Nancy Weaver** *Environmental Data Services*
IIb	Project Quantification Limits	Ensure all sample results met the project quantification and action limits specified in Worksheet 15.	**Laura Lampshire, Megan Hilton** *CH2M HILL*
IIb	Raw data	100% of data will be validated against QA/QC criteria presented in this SAP. The validator will perform a 10% review of raw data to confirm laboratory calculations.	**Nancy Weaver** *Environmental Data Services*

[1] IIa=compliance with methods, procedures, and contracts
IIb=comparison with measurement performance criteria in the SAP

SAP Worksheet #36—Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa	GW	Semivolatiles	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers that may be used are those presented in *National Functional Guidelines for Organic Data Review* (October 1999) and *National Functional Guidelines for Inorganic Data Review* (October 2004).	**Nancy Weaver** *Senior Chemist* *Environmental Data Services*
IIa	GW	Metals		
IIa	SS	Semivolatiles		
IIa	SS	Metals		
IIa	Solid	Full TCLP, Reactivity, Corrosivity, Ignitability	Data will be reviewed against the analytical methods for outstanding QA/QC issues and anomalies by the laboratory. Issues will be summarized in the case narrative. The CH2M HILL chemist and project manager will review the analytical results and case narrative before the data is loaded to ensure no major problems exist.	Marcia McGinnity, Empirical Laboratories Megan Hilton, CH2M HILL Laura Lampshire, CH2M HILL
IIb	GW	Semivolatiles	Project measurement performance criteria is located on Worksheet #15, “Reference Limits and Evaluation Table”	Chemist, CH2M HILL Laura Lampshire, CH2M HILL
IIb	GW	Metals		
IIb	SS	Semivolatiles		
IIb	SS	Metals		
II b	Solid	Full TCLP, Reactivity, Corrosivity, Ignitability		

SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

Non-detected contaminants will be evaluated to ensure that project-required quantitation limits in Worksheet #15 were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.

During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases are not considered usable for project decisions.

For statistical comparisons, non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions.

Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.

Field and laboratory precision will be compared as relative percent difference (RPD) between the two results.

Deviations from the SAP will be reviewed to assess whether corrective action is warranted and to assess impacts to achievement of project objectives.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

To assess whether a sufficient quantity of acceptable data are available for decision making, the data will be reconciled with measurement performance criteria following validation and review of data quality indicator.

If significant biases are detected with laboratory QA/QC samples it will be evaluated to assess impact on decision making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site.

If significant deviations are noted between lab and field precision the cause will be further evaluated to assess impact on decision making.

Identify the personnel responsible for performing the usability assessment:

The CH2M HILL Project Manager and Project Chemist with contributions from other team members as necessary.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

Data tables will be prepared that will show each compound that was analyzed and each compound that was detected. The project chemist will identify any data quality issues that could potentially affect the usability of the data. This information will be passed along to the project team who as a whole will decide upon the usability of the data.

Figures

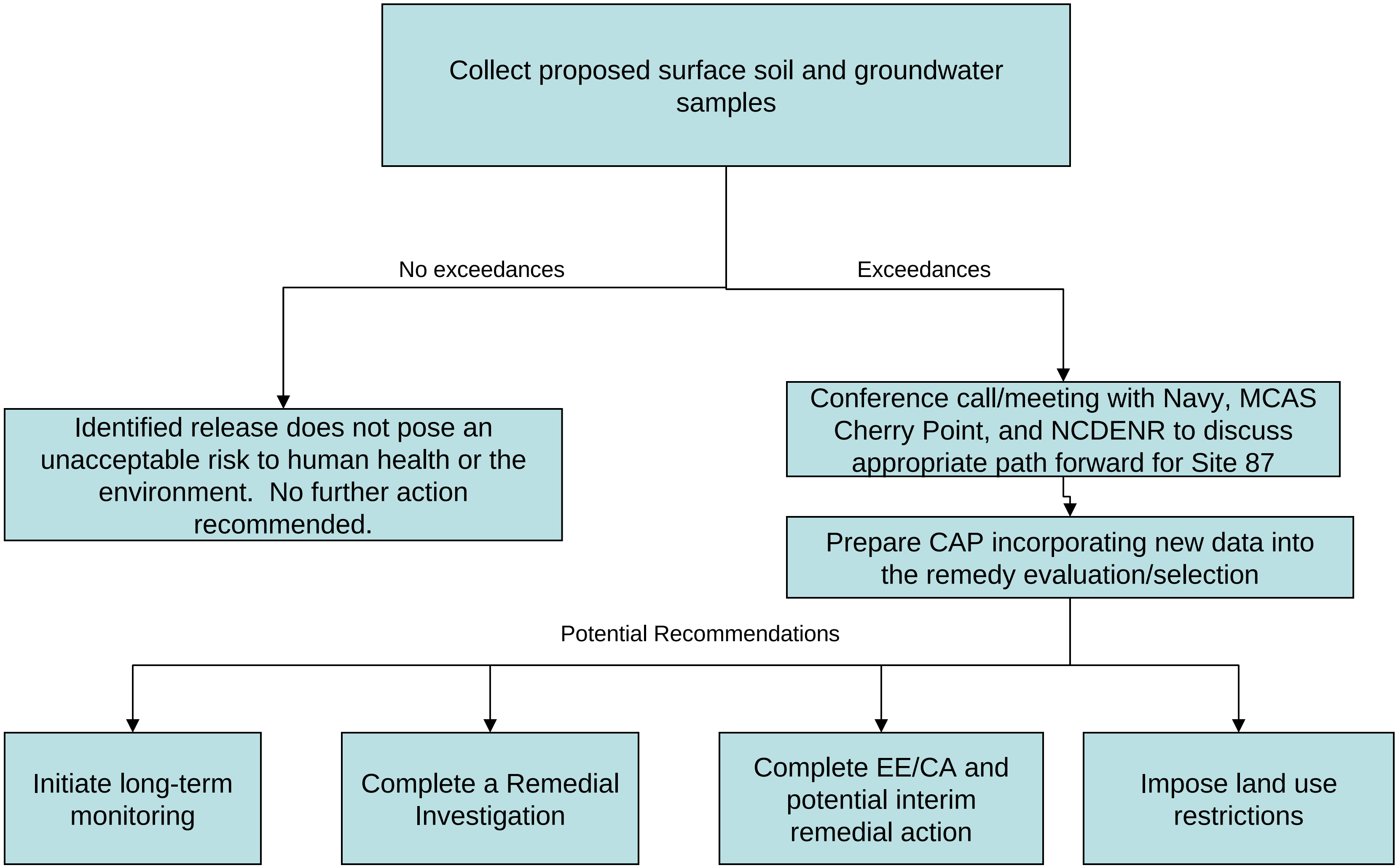


Figure 1
Decision Tree
Site 87, BT-11, MCAS Cherry Point, North Carolina
Supplemental Site Investigation Work Plan

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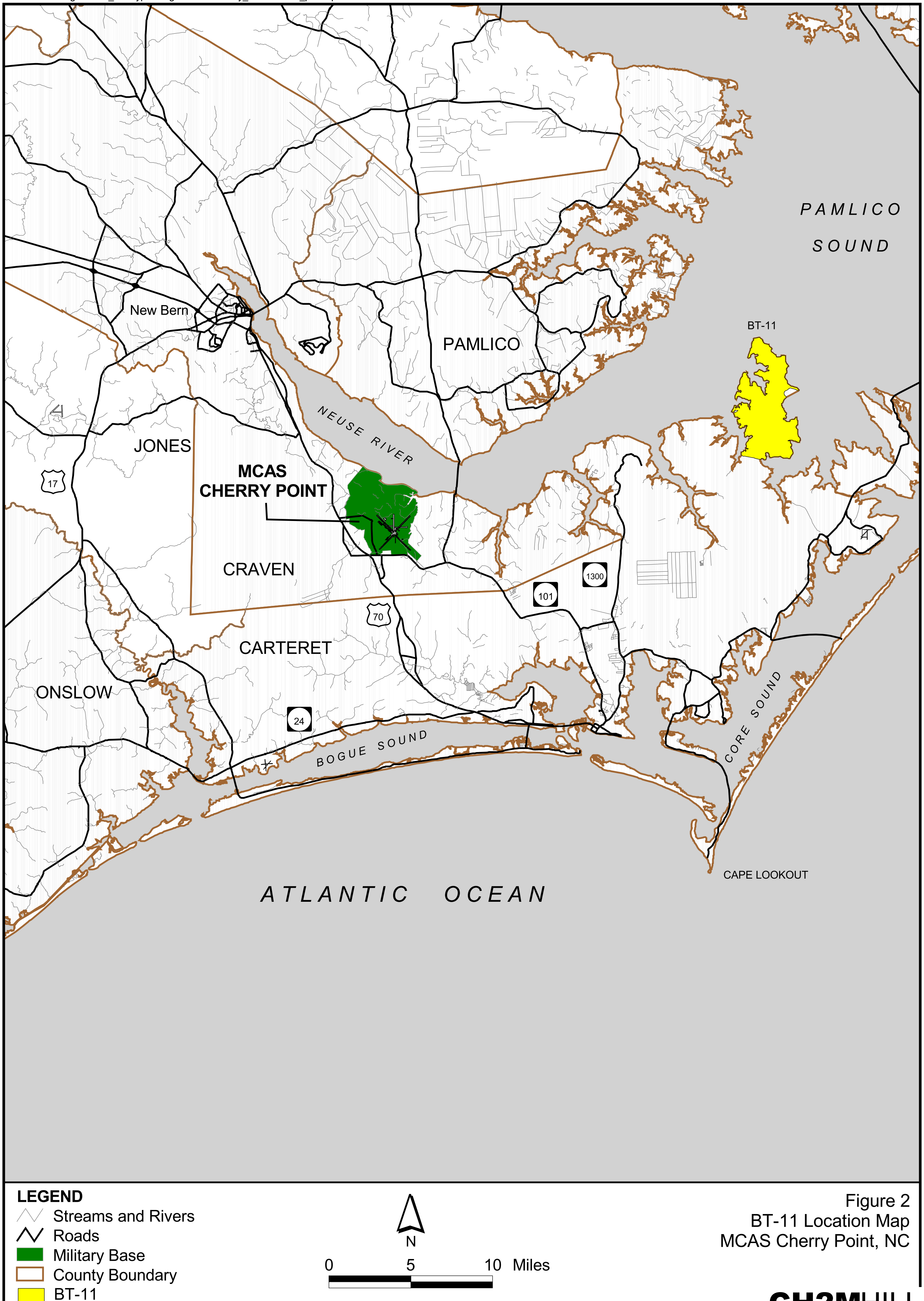

Figure 2
BT-11 Location Map
MCAS Cherry Point, NC

CH2MHILL

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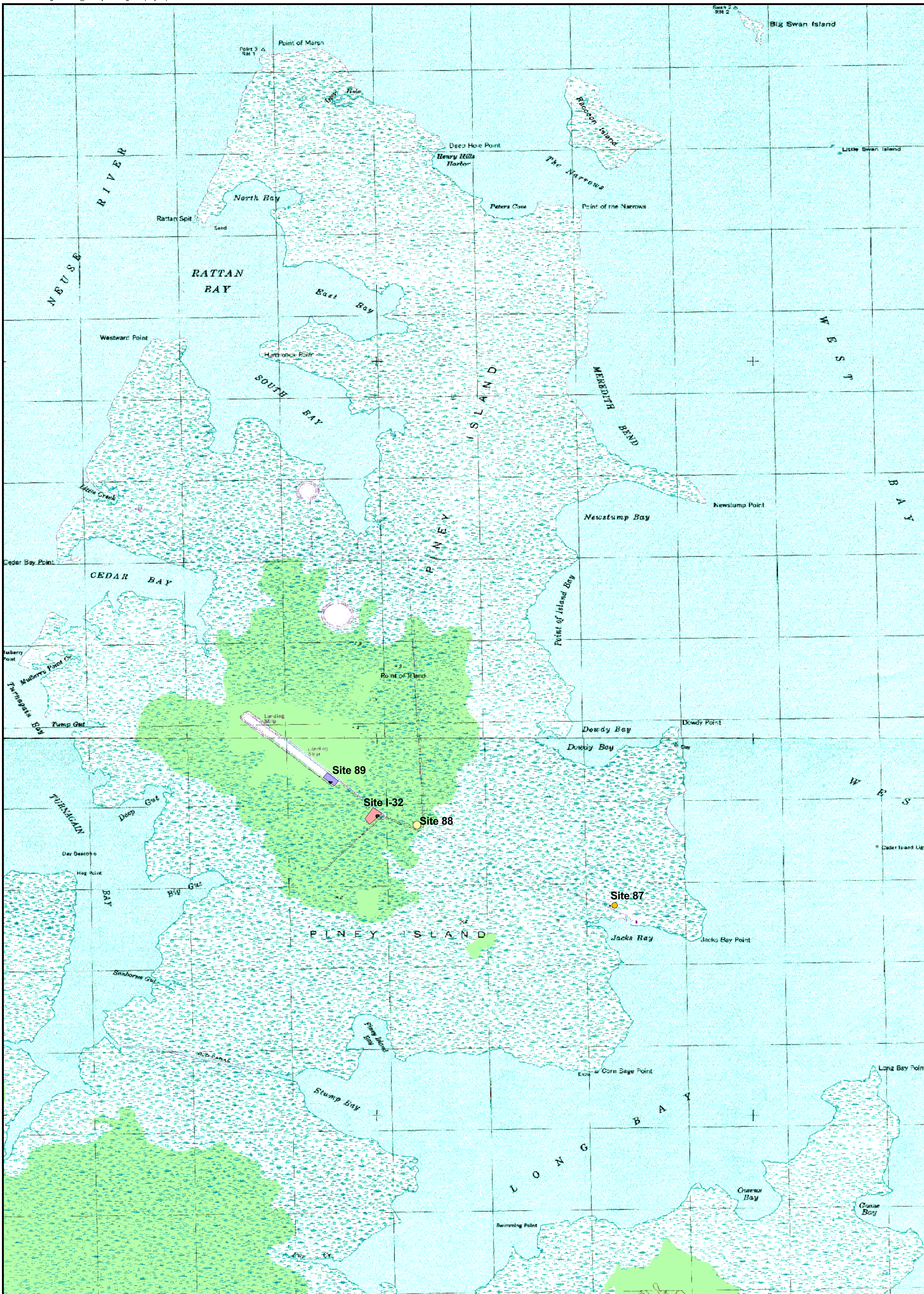

LEGEND

Landing Strip

N

0 3000 6000 Feet

Figure 3
Site Layout Map
BT-11
MCAS Cherry Point, NC

Source: Point of Marsh, NC and Long Bay, NC 7.5-minute USGS Quadrangle Maps

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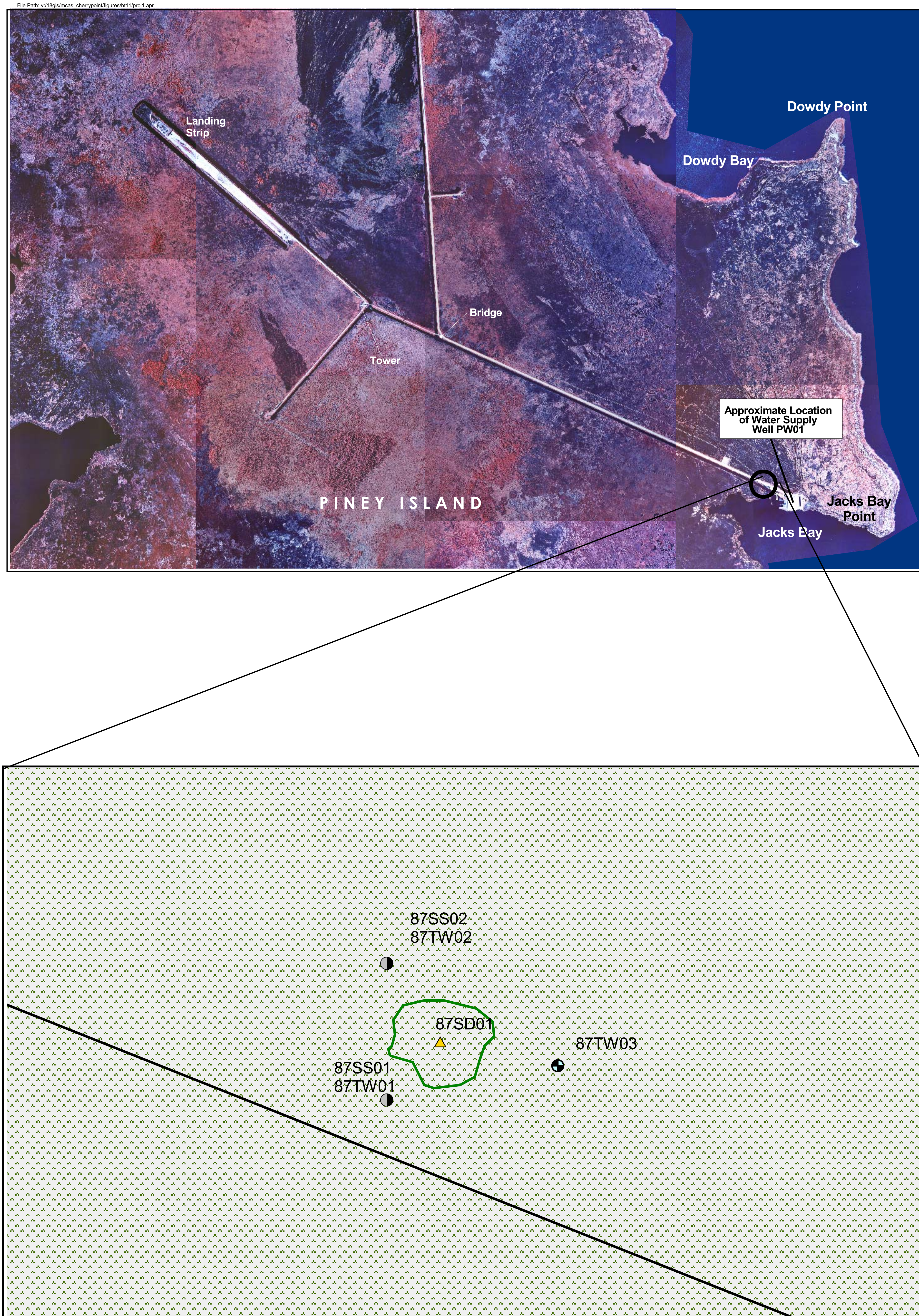

LEGEND
- Soil and Groundwater Sampling Location
- Sediment Sampling Location
- Groundwater Only Sampling Location
- Roads
- Estimated Limits of Waste
- Emergent Persistant - Mesohaline Wetland

N

0 5 10 Feet

Figure 4
1999-2000 Sample Locations
Site 87, BT-11
MCAS Cherry Point, NC

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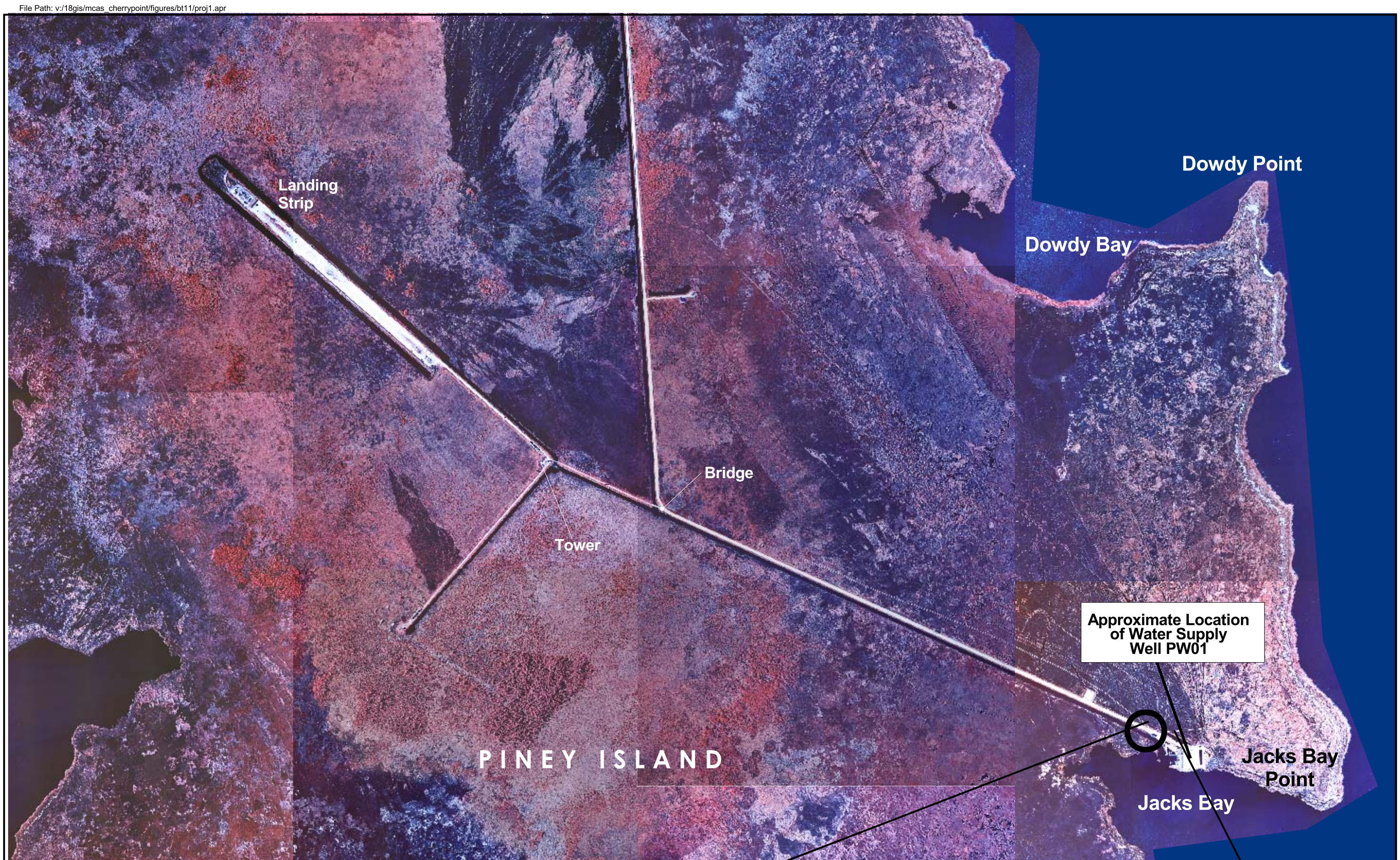

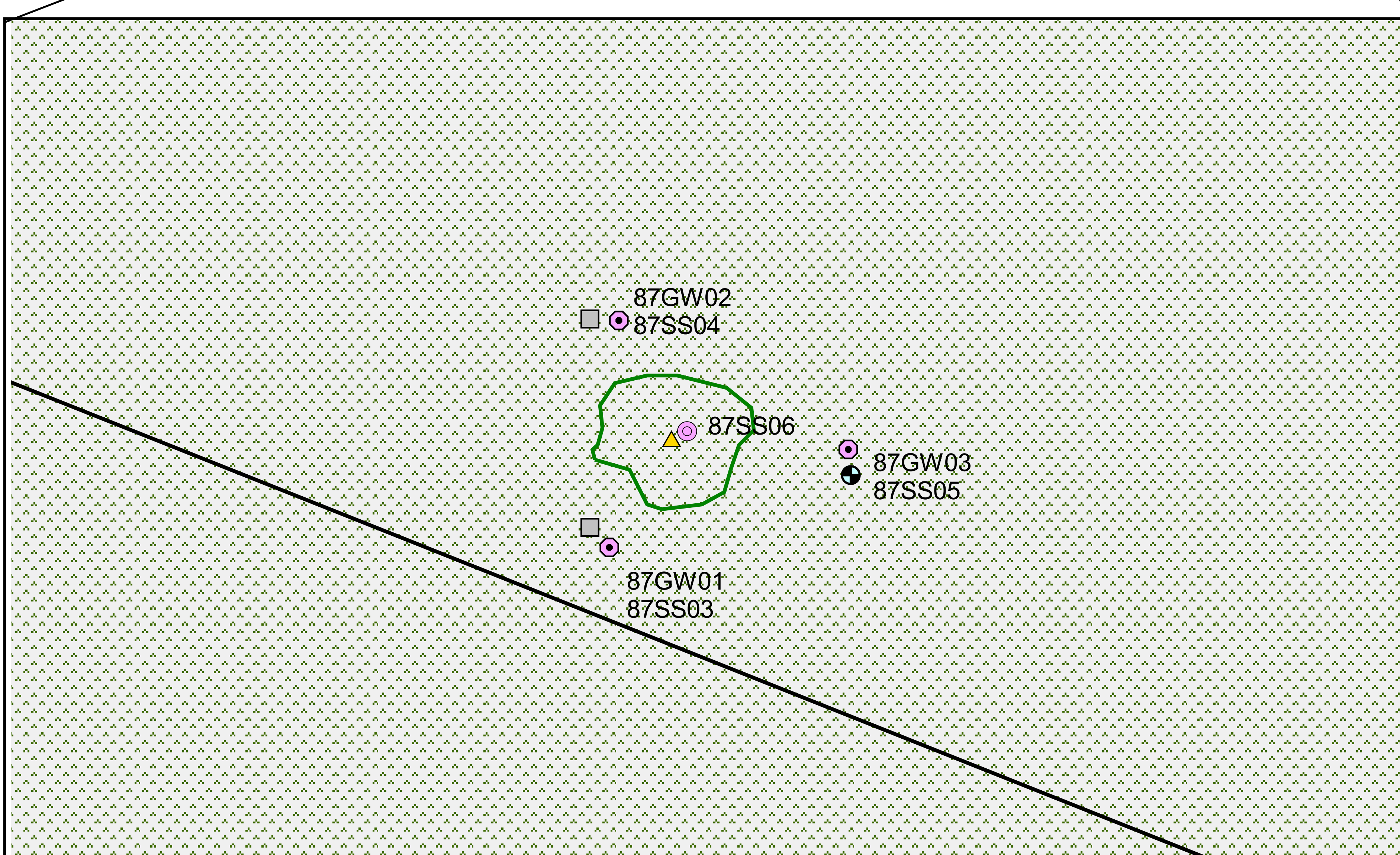

LEGEND

- Proposed Soil and Groundwater Sampling Location
- Proposed Soil Only Sampling Location
- 1999-2000 Soil and Groundwater Sampling Location
- 1999-2000 Groundwater Only Sampling Location
- 1999-2000 Sediment Sampling Location
- Estimated Limits of Waste
- Emergent Persistant - Mesohaline Wetland

Roads

N

0 5 10 Feet

Figure 5
Proposed Sample Locations
Site 87, BT-11
MCAS Cherry Point, NC

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Appendix A
Analytical Laboratory SOPs

Laboratory SOPs are proprietary and confidential. They are held by CH2M HILL and the Navy and are available upon request.

Appendix B
Field SOPs

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II grade water.

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FIGURES

1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Geologist. Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used on site, the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 Materials Needed

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute hydrochloric acid (HCl)
- Ruler (marked in tenths and hundredths of feet)
- Hand Lens

5.2 Classification of Soils

All data shall be written directly on the boring log (Figure 1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (Continued).

FIGURE 1

BORING LOG (EXAMPLE)

BORING LOG

Page ___ of ___

PROJECT NAME: ____________ BORING NUMBER: ____________
PROJECT NUMBER: ____________ DATE: ____________
DRILLING COMPANY: ____________ GEOLOGIST: ____________
DRILLING RIG: ____________ DRILLER: ____________

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION			USCS *	Remarks	PID/FID Reading (ppm)			
					Soil Density/ Consistency or Rock Hardness	Color	Material Classification			Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Remarks: ____________

Drilling Area Background (ppm): ____

Converted to Well: Yes ______ No ______ Well I.D. #: ____________

FIGURE 1 (CONTINUED)

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE-GRAINED SOILS
More Than Half of Material is LARGER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS (50%(+)>1/4"∅	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel sand-clay mixtures.
SANDS 50%(+)<1/4"∅	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand silt mixtures.
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand clay mixtures.

FINE-GRAINED SOILS
More Than Half of Material is SMALLER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)				GROUP SYMBOL	TYPICAL NAMES
Identification Procedures on Fraction Smaller than No. 40 Sieve Size					
	DAY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS AND CLAYS Liquid Limit <50	None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
	Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
SILTS AND CLAYS Liquid Limit >50	Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.
	Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel sand mixture with clay binder.
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS			
CONSISTENCY	UNC COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb.
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENNESS		
Descriptive Terms	Screwdriver or Knife Effects	Hammer Effects	Descriptive Terms	Abbreviation	Spacing
Soft	Easily Gouged	Crushes when pressed with hammer	Very Broken	(V. Br.)	0-2"
Medium Soft	Can be Gouged	Breaks (one blow); crumbly edges	Broken	(Br.)	2"-1'
Medium Hard	Can be scratched	Breaks (one blow); sharp edges	Blocky	(Bl.)	1'-3'
Hard	Cannot be scratched	Breaks conchoidally (several blows); sharp edges	Massive	(M.)	3'-10'

LEGEND:

SOIL SAMPLES - TYPES

S-2" Split-Barrel Sample
ST-3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X-NX (Conventional) Core (-2-1/8" O.D.)
Q-NQ (Wireline) Core (-1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▼ 12.6' Initial Level w/Date & Depth

12/18
▼ 12.6' Stabilized Level w/Date & Depth

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils shall be divided into rock fragments, sand, or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as "(1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.3. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure 2.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength), or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in Figure 2.

FIGURE 2

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Figure 3.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

FIGURE 3

BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
< 1 mm	<1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

5.3 Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.

- Claystone - Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine-grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

5.3.1 Rock Type

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Figure 4 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock color charts shall not be used unless specified by the Project Manager.

5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification (see Figure 3) will also be used for rock classification.

5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

FIGURE 4

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 0.25 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm

After Wentworth, 1922

5.3.5 Fracturing

The degree of fracturing or brokenness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2-inch spacing between fractures
- Broken (BR.) - 2-inch to 1-foot spacing between fractures
- Blocky (BL.) - 1- to 3-foot spacing between fractures
- Massive (M.) - 3 to 10-foot spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD
(After Deere, 1964)

$$RQD\ \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified).

- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inches or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse-grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.

- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.

- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.

- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.

- Quartzite - A fine- to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

5.4 Abbreviations

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C - Coarse	Lt - Light	Yl - Yellow
Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine-grained
Tr - Trace		

5.5 Boring Logs and Documentation

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections shall be used to complete the logs. A sample boring log has been provided as Figure 5.

The field geologist/engineer shall use this example as a guide in completing each boring log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use.

FIGURE 5
COMPLETED BORING LOG (EXAMPLE)

BORING LOG

Page 1 of 1

PROJECT NAME: NSB- SITE
PROJECT NUMBER: 9594
DRILLING COMPANY: SOILTEST CO.
DRILLING RIG: CME-55
BORING NUMBER: SB/MW 1
DATE: 3/8/96
GEOLOGIST: SJ CONTI
DRILLER: R. ROCK

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ
S-1	0.0	7/6	1.5/2.0		M DENSE	BRN	SILTY SAND - SOME	SM	MOIST SL. ORG.	5	0	0	0
@ 0800	2.0	9/10				TO BLK	ROCK FR.: TR BRICKS		ODOR				
							(FILL)		FILL TO 4'±				
	4.0			4.0									
S-2 @		5/7	2.9/2.0		M DENSE	BRN	SILTY SAND - TR FINE	SM	MOIST - W ODOR	10	0	-	-
0810	6.0	9/8					GRAVEL		NAT. MATL. TOOK SAMPLE				
	•			7'± ▽					SB01-0406 FOR ANALYSIS				
	8.0			8.0									
S-3 @		6/8	1.9/2.0		DENSE	TAN BRN	FINE TO COARSE SAND	SW	WET	0	0	0	0
0820	10.0	17/16					TR. F. GRAVEL		HIT WATER ≈ 7'±				
	12.0			12.0									
S-4 @		7/6	1.6/2.0		STIFF	GRAY	SILTY CLAY	CL	MOIST → WET	0	.5	-	-
0830	14.0	5/8											
	15.0			15.0					AUGER REF @ 15'				
				15.5 16	M HARD	BRN	SILTSTONE	WBR	WEATHERED				
									LO ∠ JNTS @ 15.5				
9/5	1		4.0/5.0						WATER STAINS @ 16.5, 17.1, 17.5	0	0	0	0
				19'					LOSING SOME				
	20.0				HARD	GRAY	SANDSTONE - SOME	BR	DRILL H2O @ 17'±				
							SILTSTONE		SET TEMP 6" CAS TO 15.5				
4.9/5.0	2		5.0/5.0						SET 2" Ø PVC SCREEN 16-25	0	0	0	0
									SAND 14-25				
	25.0			25					PELLETS 12-14				

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

• 1-20Z
1-80Z

Drilling Area Background (ppm): 0

Remarks: CME-55 RIG, 4 1/4" ID HSA - 9" OD ±
2" SPLIT SPOONS - 140 LB HAMMER - 30" DROP
NX CORE IN BEDROCK RUN ① = 25 min, RUN ② = 15 min

Converted to Well: Yes ✓ No ____ Well I.D. #: MW-1

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.

- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology at 13.7 feet, shall be lined off at the proportional location between the 13- and 14-foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split-spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart on back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace: 0 - 10 percent
  - Some: 11 - 30 percent
  - And/Or: 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the "Remarks" column and shall include, but is not limited by, the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

- Angularity - describe angularity of coarse grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.

- Particle shape - flat, elongated, or flat and elongated.

- Maximum particle size or dimension.

- Water level observations.

- Reaction with HCl - none, weak, or strong.

• Additional comments:

- Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

- Indicate odor and Photoionization Detector (PID) or Flame Ionization Detector (FID) reading if applicable.

- Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.

- At the bottom of the page indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).

- Vertical lines shall be drawn (as shown in Figure 5) in columns 6 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.

- Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 Rock Classification

• Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent, and core recovery under the appropriate columns.

• Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.

• Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.

- Enter brokenness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:

  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.

  - Indicate calcareous zones, description of any cavities or vugs.

  - Indicate any loss or gain of drill water.

  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:

  - Type and size of core obtained.

  - Depth casing was set.

  - Type of rig used.

- As a final check the boring log shall include the following:

  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.

  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5-foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date, etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.
- Record this and any other useful information onto the boring log as provided in Figure 1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split-barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 Review

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs.
- Checking for conformance to the guideline.
- Checking to see that all information is entered in their respective columns and spaces.

6.0 REFERENCES

Unified Soil Classification System (USCS).

ASTM D2488, 1985.

Earth Manual, U.S. Department of the Interior, 1974.

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

STANDARD OPERATING PROCEDURE

Civil Surveying

I. Purpose and Scope

The SOP describes survey procedures to be used on CLEAN projects. Modified third-order survey procedures will be used for most surveying. Geographic Positioning System techniques will be used for measurement of some horizontal coordinates.

II. Records and Definitions

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field identification number and environmental settings. Graphite pencils or waterproof ballpoint pens should be used. Erasing is not acceptable; use a single-strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work. Field notebooks will be available on site.

The following terms are defined to clarify discussion in this SOP:

- North American Datum (NAD) -The standard geodetic datum on the North American continent.
- National Geodetic Vertical Datum (NGVD) - The vertical-control datum used (1929 or later) by the National Geodetic Survey for vertical control.
- Horizontal Control - Horizontal location of an object from surveyed corners or other features on permanent land monuments in the immediate site area. Will be based on North American Datum (NAD) 1983 and state plane grid systems.
- Vertical Control - Vertical location of an object compared to the adjacent ground surface.
- Bench Mark - Precisely determined elevation above or below sea level. May also have horizontal control (northing, easting) determined for location.

III. Surveying

Horizontal Survey

Horizontal angular measurements shall be made with a 20-second or better theodolite or transit. When using a 20-second instrument the horizontal angles shall be turned four times (two each direct and inverted) with the mean of the fourth angle being within 5 seconds of the mean of the second angle. When using a 10-second or better instrument the angles shall be doubled (once each direct and inverted), with the mean of the second angle within 5 seconds of the first angle. The minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a calibrated steel tape corrected for temperature and tension or a calibrated electronic distance meter (EDM). When using an EDM the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 20 seconds of arc deviation from the horizontal plane. Horizontal locations will be surveyed to within 0.05-foot of the true location.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

The horizontal location will be referenced to NAD83 and the appropriate state plane grid system.

Some horizontal coordinates will be measured using Geographic Positioning System (GPS) equipment. This approach will be used in particular for determining the coordinates of surface-water and sediment sampling locations, and may be used also for determining the locations of piezometers and monitoring wells. The GPS survey will be performed by staff trained in the use of the equipment and will conform to guidance provided by the manufacturer.

Vertical Survey

When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent benchmark. If practical, level circuits should close on a known benchmark other than the starting benchmark. The following criteria shall be met in conducting the survey:

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.
- Rod readings shall be made to 0.01-foot and estimated to 0.005-foot.
- Elevations shall be adjusted and recorded to 0.01-foot.

Temporary benchmarks (TBMs) shall be established and referenced for future use. All TBMs shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBMs shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc.

(Horizontal traverse stations will not be considered as a TBM, but may be used as a permanent turning point.)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step One—Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
- Step Two—Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule.
- Step Three—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.
- Step Four—The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Piezometer and Monitoring-Well Surveys

Piezometer and monitoring-well locations will be surveyed only after the installation of the protective casing, which is set in concrete. The horizontal plane survey accuracy is ±0.05-foot and is measured to any point on the protective-casing cover. The vertical plane survey must be accurate to ±0.01-foot. The following two elevations will be measured at piezometers and monitoring wells:

- Top of the piezometer or well riser (not on the protective casing), preferably on the north side
- Ground surface, preferably on the north side of the well

If no notch or mark exists, the point at which the elevation was measured on the inner casing shall be described so that water-level measurements may be taken from the same location.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is $\pm$ 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

Exhibit A
STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

Traverse

Max Number of bearing courses between azimuth checks	30
Astronomical bearings: standard error of results	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000

Leveling

Levels error of closure per loop in feet	0.05 $\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,

- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign with the appropriate sample/location number.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening so that it would be broken if the container were to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water)
- Distilled water
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Phthalate-free gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep hoses from touching the ground
3. Turn off pump after sampling. Remove pump from well and place pump in decontamination tube, making sure that tubing does not touch the ground
4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.
5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 1 gallon of tap water.
7. Rinse with 1 gallon of deionized water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Navy
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox®
- Buckets
- Brushes
- Distilled organic-free water
- Methanol, pesticide grade
- ASTM–Type II grade water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, and between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

a. Rinse with tap water
b. Rinse with de-ionized water
c. Solvent rinse with methanol
d. Rinse with de-ionized water

2. Probes

Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with methanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis. Anytime a sampling event occurs, at least one such quality control sample shall be collected.

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks And Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. References

A. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C., 1987.

B. *Data Quality Objectives for Remedial Activities - Development Process*, EPA/540/G-87/003, U.S. Environmental Protection Agency, Washington, D.C., 1987.

C. Annual Book of ASTM Standards, *Standard Recommended Practices for Sampling Industrial Chemicals*, ASTM-E-300, 1986.

D. *Test Method for Evaluating Solid Waste*, SW-846, Volume II, Field Methods, Second Edition, U.S. Environmental Protection Agency, Washington, D.C., 1982.

E. U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites – A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

F. *Environmental Surveillance Procedures*, Quality Control Program, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

III. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

IV. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

V. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safety plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

VI. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.

2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.

3. If possible, stage drums for easy access.

4. If necessary, attach ground strap to drums and grounding point.

5. Remove any standing material (water, etc.) from container top.

6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.

8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.

9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be

recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).

11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.

3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.

4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.

5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.

2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.

4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)

5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.

6. Sample each trailer compartment.

7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

<u>Drum</u>

Glass tube	—	Procedure 1
COLIWASA	—	Procedure 2

<u>Storage Tank and Tank Trailer</u>

COLIWASA	—	Procedure 2
Bacon Bomb	—	Procedure 3
Gravity Corer (for bottom sludge)	—	Procedure 4

VII. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

IX. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for "waste," so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.

2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.

6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

<u>Uses</u>

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

<u>Procedures for Use</u>

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.

2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.

3. Allow corer to free fall through the liquid to the bottom.

4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.

5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).

6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked “NON SPARKING” is encouraged. However, the use of a “NON SPARKING” wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged

[1] Taken from EPA Training Course: “Sampling for Hazardous Materials,” U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4- foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, “sprayers” may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be “staged,” or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time- consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

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		Prepared: Earth Sciences Department	
Subject: GROUNDWATER MONITORING POINT INSTALLATION		Approved: D. Senovich	

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1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of permanent monitoring wells. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be determined during the project planning phases of the investigation, and any required permits must be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

Monitoring Well - A well which is properly screened (if screening is necessary, e.g., open borehole), cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch-diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface representative of the level to which water will rise in a well cased to the screened aquifer.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Rig Geologist - The rig geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

5.0 PROCEDURES

5.1 Equipment/Items Needed

Below is a list of items that may be needed when installing a monitoring well:

- Health and safety equipment as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installations tools (sledge hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 Well Design

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials to be used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity).

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, groundwater flow and potential well locations can be determined through the review of geologic data and the site terrain. In addition, data from production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary investigative phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored interval must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the levels at which contaminants are present. Conversely, a fully penetrating well is usually not used to quantify or vertically locate a contaminant plume, since groundwater samples collected in wells that are screened over the full thickness of the water-bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of contamination in the water-bearing zone. The well diameter desired depends upon the hydraulic characteristics of the water-bearing zone, sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- The vertical location of the contaminant source in relation to the water-bearing zone.
- The depth, thickness and uniformity of the water-bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (1 to 2 feet) are usually required where flow lines are not horizontal. (i.e., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs.

Standard monitoring well diameters are 2, 4, 6, or 8 inches. However, drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch-diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open-hole monitoring wells are required. In the smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced, however, the type of sampling devices that can be used are limited. In specifying well diameter, sampling requirements must be considered (up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples). The volume of water in the monitoring well available for sampling is dependent on the well diameter as follows:

Casing Inside Diameter (Inch)	Standing Water Depth to Obtain 1 Gallon Water (Feet)	Total Depth of Standing Water for 4 Gallons (Feet)
2	6.13	25
4	1.53	6
6	0.68	3

However, if a specific well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells; however, in small-diameter wells in-situ permeability tests can be performed during drilling or after well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength" and Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation; risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive presentation on this topic). The two most commonly used materials are PVC and stainless steel for wells in which screens are installed. Properties of these two materials are compared in Attachment B. Stainless steel is preferred where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, and ease of manipulation; however, there are also some questions about organic chemical sorption and leaching that are currently being researched (see Barcelona et al., 1983). Concern about the use of PVC can be minimized if PVC wells are used strictly for geohydrologic measurements and not for chemical sampling. The crushing strength of PVC may limit the depth of installation, but Schedule 80 materials normally used for wells greater than 50 feet deep may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps required for sampling or testing. Due to this problem, the minimum well pipe size recommended for Schedule 80 wells is 4-inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe, may corrode and release metal ions or chemically react with organic constituents, but this is considered by some to be less of a problem than the problem associated with PVC material. Galvanized steel is not recommended where samples may be collected for metal analyses, as zinc and cadmium levels in groundwater samples may become elevated from leaching of the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints at slightly more costs. Welded-joint steel casing is also acceptable. Glued PVC may release organic contaminants into the well, and therefore, should not be used if the well is to be sampled for organic constituents.

When the water-bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary and the screened interval is artificially packed with a fine sand. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The rig geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water-bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. For example, as a standard procedure, a Morie No. 1 or No. 10 to No. 20 U.S. Standard Sieve size filter pack is typically appropriate for a 0.020-inch slot screen; however, a No. 20 to No. 40 U.S. Standard Sieve size filter pack is typically appropriate for a 0.010-inch slot screen.

5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a fine-to medium-grained poorly graded, silica sand and should relate to the grain size of the aquifer sediments. The quantity of sand placed in the annular space is dependent upon the length of the screened interval, but should always extend at least 1 foot above the top of the screen. At least 1 to 3 feet of bentonite pellets or equivalent shall be placed above the sand pack. Cement-bentonite grout (or equivalent) is then placed to extent from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally (i.e., no artificial sand pack installed), and the natural formation material is allowed to collapse around the well screen after the well is installed. This method has been used where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging, and to provide a better seal. However, in shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of two assemblages of material, (e.g., cement-bentonite). A cement-bentonite grout normally is a mixture of cement, bentonite, and water at a ratio of one 90-pound bag of Portland Type I cement, plus

3 to 5 pounds of granular or flake-type bentonite, and 6 gallons of water. A neat cement consists of one ninety-pound bag of Portland Type I cement and 6 gallons of water.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets or equivalent. A short (1- to 2-foot) section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is often placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A protective casing which is level with the ground surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter protective sleeve is set into the wet cement around the well with the top set level with the pavement. A manhole-type lid placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 Monitoring Well Installation

Pertinent data regarding monitoring well installation shall be recorded on log sheets as depicted and discussed in SOP SA-6.3. Attachments to this referenced SOP illustrate terms and physical construction of various types of monitoring wells.

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur.

After the sand pack is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent), can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack.

The cement-bentonite grout is then mixed and either poured or tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

In stable formations where borehole collapse does not occur, the well can be installed as discussed above, and the use of a temporary casing is not needed. However, centralizers may have to be installed, one above and one below the screen, to assure enough annular space for sand pack placement.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between the unconfined and confined aquifer. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 3 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting the outer casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for installation of the monitoring well as detailed for overburden monitoring wells (with the exception of not using a temporary casing during installation). Sufficient time (determined by the rig geologist), must be allowed for setting of the grout prior to drilling through the confined layer.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 feet into the bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued through the bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. However, if a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be installed temporary until final well installation is completed.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be driven to depths exceeding 10 feet.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only one or two small-diameter tubes extending to the surface.

Manufacturers of these types of samplers claim that four samplers can be installed in a 3-inch-diameter borehole. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross-contamination from sampling equipment. These samplers also perform well when the water table is within 25 feet of the surface (the typical range of suction pumps). Two manufacturers of these samplers are Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, and BARCAD Systems, Inc., of Concord, Massachusetts. Each manufacturer offers various construction materials.

Two additional types of multilevel sampling systems have been developed. Both employ individual screened openings through a small-diameter casing. One of these systems (marketed by Westbay Instruments Ltd. of Vancouver, British Columbia, Canada) uses a screened port and a sampling probe to obtain samples and head measurements or perform permeability tests. This system allows sampling ports at intervals as close as 5 feet, if desired, in boreholes from 3 to 4.8 inches in diameter.

The second system, developed at the University of Waterloo at Waterloo, Ontario, Canada, requires field assembly of the individual sampling ports and tubes that actuate a simple piston pump and force the samples to the surface. Where the depth to ground water is less than 25 feet, the piston pumps are not required. The assembly is made of easily obtained materials; however, the cost of labor to assemble these monitoring systems may not be cost-effective.

5.4 Well Development Methods

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity and temperature taken during development may yield information (stabilized values) that sufficient development is reached. The selection of the well development method shall be made by the rig geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

5.4.1 Overpumping and Backwashing

Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods, including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

5.4.2 Surging with a Surge Plunger

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is used to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

5.4.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping of the well is subsequently done using the air lift method.

5.4.4 High Velocity Jetting

In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 REFERENCES

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7.0 RECORDS

A critical part of monitoring well installation is recording of significant details and events in the site logbook or field notebook. The geologist must record the exact depths of significant hydrogeological features screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachments to SOP SA-6.3) shall be completed thus ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information shall include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded.depending on whether the well is completed in overburden, in a confined layer, in bedrock with a cased well, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist shall calculate the annular space volume and have a general idea of the quantity of material needed to fill the annular space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in. Any problems with rig operation or down-time shall be recorded and may affect the driller's final fee.

ATTACHMENT A

RELATIVE COMPATIBILITY OF RIGID WELL CASING MATERIAL (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material						
	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless Steel 304	Stainless Steel 316	Teflon*
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Mineral Acid/ High Solids Content	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials:

1 Teflon®
2 Stainless Steel 316
3. Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel

* Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material								
	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton®*	Silicone	Neoprene	Teflon®*
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/ High Solids Content	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials:

1 Teflon®
2 Polypropylene (PP)
3. PVC Flexible/PE Linear
4 Viton®
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene

* Trademark of DuPont

Source: Barcelona et al., 1983

ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength are not critical.
Weight	Relatively heavier.	Light-weight; floats in water.
Cost	Relatively expensive.	Relatively inexpensive.
Corrosivity	Deteriorates more rapidly in corrosive water.	Non-corrosive -- may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated hydrocarbons.
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work with in the field.
Preparation for Use	Should be steam cleaned organics will be subsequently sampled.	Never use glue fittings -- pipes should be threaded or pressure fitted. Should be steam cleaned when used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized.	May sorb or release organic substances.

* See also Attachment A.

STANDARD OPERATING PROCEDURE

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon opening the spoon and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP *Decontamination of Personnel and Equipment* prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

V. Attachments

None.

VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless steel bowl.

STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using the Horiba® U-22 with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using the Horiba® U-22 for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Horiba® U-22 Water Quality Checker with flow-though cell
- Distilled water in squirt bottle
- Horiba® U-22 Auto-Calibration Standard Solution

III. Procedures and Guidelines

A. Parameters and Specifications:

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 ^{o}C	+/- 1.0 ^{o}C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using Horiba® Standard Solution. Calibration procedure:

1. Fill the calibration beaker to about 2/3 with the pH 4 standard solution.

2. Fit the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.

3. Turn power on.

4. Press CAL key to put the unit in the calibration mode.

5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.

6. If the unit is calibrated properly, pH will read 4.0 +/- 3%, conductivity will read 4.49 +/- 3%, and turbidity will read 0 +/- 3%

C. Sample Measurement:

As water passes through the flow-through Cell, press MEAS to obtain reading; record in the field notebook.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

CLICK HERE TO GET TO ATTACHMENTS

Waste Management: Analysis and Characterization Enterprise Standard Operating Procedure HSE-408

1.0 Purpose

This Enterprise Standard Operating Procedure (SOP) describes procedures for analyzing and characterizing waste streams generated on CH2M HILL projects. It is designed to be used in conjunction with HSE-413, Waste Management Planning.

2.0 Scope and Application

2.1 Scope

Managing waste from construction, demolition, remediation, or other field activities at CH2M HILL project sites is an important aspect of our business. This Waste Analysis and Characterization SOP lists the proper procedures to determine the regulatory status of wastes and is applicable to project activities that generate waste.

2.2 Application

This SOP applies Enterprise Wide to all CH2M HILL Legal Entities and Business Groups, their employees, subcontractors and their lower-tier subcontractors that operate in the United States (US) and internationally.

Some state environmental or OSHA programs may have more stringent requirements. State regulations may be found under Regtools. Contact the appropriate Responsible Environmental Manager (REM) to address these specific requirements. This SOP should be used as a starting point for international operations, but country-specific health, safety and environmental (HSE) regulations shall prevail, and a country-specific SOP should be developed to comply with these specific HSE regulations.

2.3 Applicable Enterprise SOPs

Applicable Enterprise Standards of Practice and Standard Operating Procedures that are applicable to this SOP are as follows:

- HSE-413, Waste Management: Planning

3.0 Definitions

3.1 Chain-of-Custody Form

A form that documents the transfer of custody and responsibility from the sampling personnel to the laboratory. This form also documents the identification of the samples and the analyses requested.

3.2 Characterization

Characterization is the process where waste constituent concentrations are identified and compared to legal requirements or threshold levels that affect waste disposal methods. The generator of the waste is required by law to perform this process. The process may include evaluation of historical or MSDS information and/or analytical sampling and analysis.

3.3 Custody Seal

A label with adhesive backing that is placed on the sample and/or shipping container to enable detection of sample tampering.

3.4 Detection Limit

A detection limit is the expression for the minimum value reported by the laboratory for an analytical test method for a given constituent. Other terms that may be used in consultation with the laboratory include practical quantitation limit (PQL), sample quantitation limit (SQL), method detection limit (MDL), and project-specific reporting limit (PRL).

3.5 Generator

A generator is any person whose act or process produces hazardous waste or whose act first causes hazardous waste to become subject to regulation.

3.6 Logbook

A bound field notebook, with consecutively pre-numbered pages, that is clearly identified with the name of the project activity, the person responsible for maintenance of the notebook, and the beginning and ending dates of the entries.

3.7 Regulatory Level

A regulatory level is the legal standard or threshold level that determines a waste characterization.

3.8 Sample Label

A label with adhesive backing that is affixed to each individual container containing the identification of the sample, the preservatives applied to the sample, analytical method to be used, the sampling date and time, and the name of the sampler.

3.9 Transporter

A transporter is engaged in the off-site transportation of waste by air, rail, highway, or water.

4.0 Roles and Responsibilities

4.1 Project Delivery Manager (PDM)

The Project Delivery Manager (PDM) is responsible for ensuring that Project Managers are aware of the policies and procedures in this SOP.

4.2 Project Manager (PM)

The Project Manager (PM) is responsible for ensuring the project is implemented in compliance with environmental requirements. The PM should work with the REM to identify CH2M HILL responsibilities, costs, and plan implementation.

4.3 Responsible Environmental Manager (REM)

The REM assists the project manager in ensuring that the project complies with environmental laws and regulations by identifying issues and resources to meet project needs.

4.4 Safety Coordinator (SC)

The Safety Coordinator is familiar with project plans, including wastewater and storm water requirements, and implements the plans in the field.

4.5 Field Sampling Personnel

Field sampling personnel are responsible for following these procedures and those listed in the Sampling and Analysis Plan during sampling activities, including recording pertinent data into the logbook to satisfy project requirements.

4.6 Project Quality Control Manager

The Project QC Manager is responsible for ensuring that all field personnel follow these procedures and complete the sampling records described in this SOP. The Project QC Manager is also responsible for the following:

- Reviewing logbook entries to ensure that the sampling event is properly and completely documented, and that each page is dated and signed
- Verifying that the Chain-of-Custody (COC) Forms have been prepared completely and properly
- Verifying that the sample labels correspond to the samples listed on the COC form, and
- Verifying that the samples collected and the analyses requested on the COC match the Sampling and Analysis Plan (SAP) and the Laboratory's Purchase Order (PO) and correct discrepancies

5.0 Procedures

CH2M HILL requires managing wastes in compliance with applicable legal requirements. Waste characterization is the client's legal responsibility. CH2M HILL will not sign documentation (e.g., manifests) that suggests CH2M HILL is assuming the client's waste characterization responsibility.

5.1 General Waste Characterization Information

As discussed in HSE-413, Waste Management Planning, it is the client's responsibility to characterize all waste streams. CH2M HILL may assist a client with waste characterization if specified in the project scope of work and all necessary approvals are obtained (see CH2M HILL Hazardous Waste Policy).

Waste stream characterization should be documented in the project file. The following should be considered when assisting a client with waste characterization:

- Assume waste is hazardous until proven non-hazardous
- Characterize before waste is generated (client may be able to do this using generator knowledge)
- Estimate waste volumes
- Identify disposal facility sampling and analytical requirements

Waste characterization requirements vary depending upon where the project is located. Consult the REM for assistance.

5.2 Waste Sampling and Analysis

Sampling and analysis may be required when a waste stream cannot be properly characterized based on historical or process knowledge, or is required pursuant to a legal requirement. This section outlines the key elements for identifying analytical requirements for managing wastes. If analysis is required, the following elements should be considered:

- Analytical methods and reporting format
- Sampling protocols

5.2.1 Identify Analytical Test Methods

Waste characterization may require multiple analytical test methods, depending upon the potential composition and legal requirements. Analytical test methods will depend upon the following considerations:

- The nature and quantity of waste
- Legal requirements for transporting, treating, and disposing of the waste
- Analytical method detection limits
- Analysis required by the disposal facility

Waste Nature and Quantity

Evaluate the historical and process information related to waste generation. This information is usually obtained through the client or a review of the MSDS. An understanding of the known and expected constituents will help determine what analytical parameters are required. The quantity of waste to be generated will also affect what types of samples may be used (e.g., composite or grab samples).

Legal Requirements

Legal requirements for waste analysis, transport, treatment, and disposal vary depending upon where the project is located. Consult the REM for state and provincial requirements.

Detection Limits

Consult with the laboratory to identify the detection limits of the proposed test methods and review the required levels that must be met. The analytical method should satisfy all the analytical requirements necessary to characterize and safely transport, treat, and dispose of the waste.

Disposal Facility Requirements

Many disposal facilities have waste acceptance criteria that are in addition to the regulatory waste characterization requirements (e.g., Paint Filter Liquids Test [EPA Method 9095]). The waste acceptance criteria may affect the test method or number of samples required per volume of waste. Contact REM to evaluate proposed disposal facilities (including landfill and wastewater treatment plants) and to identify the waste acceptance criteria for each project waste stream.

5.3 Sampling

A sampling plan should be developed to ensure analysis is based on representative samples. Consult the REM and project chemist to determine sampling requirements.

Standards for documenting field sampling activities, labeling the samples, documenting sample custody, and completing the COC form are provided in this procedure. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented. This procedure shall apply to all sample collection conducted during CH2M HILL field activities.

5.3.1 Logbook

The field logbook serves as the primary record of field activities. Entries shall be made chronologically and in sufficient detail to allow the writer or a reviewer to reconstruct each day's events. Each day's activities should be signed and dated. Any changes to the Sampling and Analysis Plan shall be documented in the field logbook. If changes need to be made to the sampling procedures or analysis (e.g., not enough recovery in a well to obtain enough groundwater sample for complete analysis), the field staff shall contact the PM (in consultation with the local REM) to determine the appropriate action (e.g., which analyses will be omitted). Field logs such as soil boring logs and groundwater sampling logs should also be used.

5.3.2 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through sample collection, transfer, analysis, and final sample disposal to ensure that the integrity of the samples are maintained. Custody of samples shall be maintained in accordance with the sample custody procedures described below.

A sample is considered to be in custody if:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access

- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

5.3.3 Sample Labels

A sample label shall be affixed on each individual sample container. Clear tape should be placed over each label to prevent the labels from tearing off, falling off, being smeared, and to prevent loss of information on the label. See Attachment 1.

5.3.4 Custody Seals

A minimum of two custody seals shall be placed on each container (bottle/jar/vial) immediately after sample collection or on sample shipping containers (coolers) prior to shipment of the samples. Custody seals will be placed in such a manner that they must be broken to open the sample container (bottle/jar/vial) or sample shipping containers (coolers).

The seals shall be placed over the left and right sides of the container's (cooler's) cover or be placed across the top of each individual sample container (bottle/jar/vial). Each custody seal must be signed and dated. Clear tape should be placed over each custody seal to prevent the custody seals from easily tearing or falling off. See Attachment 2.

5.3.5 Chain-of-Custody Form Instructions

The COC form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form also is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract. Instruction for properly completing the form and contained in Attachment 3: Chain of Custody Form and Instructions.

Field personnel shall also log individual samples onto COC forms when a sample is collected. These forms may also serve as the request for analyses.

The samplers shall sign the COC form signifying they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. If the samples are given to another person for shipment, the sampler must transfer custody of the samples to that person. This transfer shall be indicated on the COC form. When the sample shipping container (cooler) is ready for shipment to the analytical laboratory, the name of the shipping company, along with the tracking number, shall be documented on the COC form, indicating a transfer of custody from the field to the shipping company. One copy of the COC form shall be retained by the field while the original COC form is placed in a plastic zip sleeve and taped to the inside of the sample shipping container (cooler) cover.

Each sample shipping container (cooler) must be associated with a unique COC form.

The electronic version of the COC forms shall be sent by e-mail or fax to both the laboratory and the project chemist in order to alert them that the samples are in transit to the laboratory.

5.3.6 Records

The COC form shall be sent by email or faxed to the project chemist and the laboratory upon shipment of the sample shipping containers (coolers). The original COC form shall be submitted by the laboratory along with the final data packages. Any changes to the analytical requests on the COC form or the laboratory purchase order (PO) shall be made in writing to the laboratory. A copy of this written change shall be sent to the project manager, laboratory, and placed in the project files. The reason for the change shall be included in the sample log and project files so that recurring problems can be easily identified.

Following the completion of project activities, the sample logbooks, sample logs, and COC forms shall be sent to the Project Management Office (PMO) for storage in project files.

6.0 Training Requirements

Employees on projects generating waste must successfully complete the following training:

- Dangerous Goods Training
- Environmental Awareness Training
- Waste Management Training

7.0 Checklists

The HSE Self Assessment Checklist: Waste Analysis in Attachment 4 is provided as a method for verifying compliance with this SOP. The REM specifies the frequency in which this checklist shall be completed by the SC and provides this information in the project's written safety plan. The REM shall assist the SC in resolving any deficiencies identified during the self assessment. The REM may also use this checklist when performing HS audits at CH2M HILL projects, including subcontractor's activities.

8.0 References

- US Environmental Protection Agency (EPA): 40 CFR Parts 260 through 279, Resource Recovery and Conservation Act (RCRA)
- US Environmental Protection Agency (EPA): 40 CFR 761, Toxic Substances Control Act (TSCA,)
- US Department of Transportation (DOT): 49 CFR 171 through 180, Hazardous Materials

9.0 Attachments/ Appendices

Attachment 1: **Sample Label and Completion Instructions**

Attachment 2: **Custody Seal and Completion Instructions**

Attachment 3: **Chain of Custody Form and Completion Instructions**

Attachment 4: **Self-Assessment Checklist**

10.0 Approval

Revision	Date	Prepared By	Approved By:
1.0	10-08-2008	Jim Kelly	

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Attachment 1: Sample Label and Completion Instructions

Project Name: ______________________ Project No: __________

Sample ID: ____

Sample Date: ___________________ Sample Time: ___________

Sampler(s): ____

Analyses: ____

Preservatives: ____

Completion Instructions:

The following information shall be recorded with a waterproof marker on each label:

- Project name
- Project number
- Sample identification or number
- Date and time of sample collection (24 hour clock)
- Sampler's name or initials
- Sample preservatives (if applicable)
- Analyses to be performed on the sample (specifically for the specific container and preservatives—typically for water samples only). This shall be identified by the method number (or name if the number is not known).

These labels may be obtained from the analytical laboratory or printed from a computer onto adhesive labels.

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Attachment 2: Custody Label and Completion Instructions

Signature: ______________________________
Date and time______________________ Time: ______________

Completion Instructions:

The custody seals shall contain the following information:

- Signature
- Date and time the sample container (bottle/jar/vial) or sample shipping container (cooler) was sealed (24 hour clock)

The custody seals may be obtained from the analytical laboratory or printed from a computer onto adhesive labels.

Attachment 3: Chain of Custody Form and Instructions

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Waste Management: Analysis and Characterization
Standard of Practice HSE-408

Attachment 3: Chain of Custody Form and Instructions

Chain-of-Custody Form Instructions

The COC form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form also is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

1. COC Number: Assign a unique ID that is linked to the project (e.g., 152901-001, GWM35-06-24- 99)
2. Project Name: Overall name of project (e.g., NAS Whiting Field)
3. Project Phase, Site, or Task: Name of specific site/task (e.g., Building 1429 excavation)
4. Project Contact: CH2M HILL contact person at site
5. Project Number: Project number assigned including WBS or charge code
6. Task Number: Task number assigned
7. Project Tel No. and Fax No.: Numbers where laboratory can call with questions or fax preliminary results
8. Laboratory Name and Contact: Name of lab where samples are to be sent and contact person
9. Lab PO Number: Laboratory Purchase Order number for the particular sampling event
10. Lab Tel No and Fax No: Numbers to call lab with questions and to fax copy of COC
11. Fax and Mail Reports to; Recipient 1 (Name and Company): Person and company where prelim and/or final copy of analytical results are to be sent
12. Fax and Mail Reports to; Recipient 2 (Name and Company): Person and company where prelim and/or final copy of analytical results are to be sent if to more than one
13. Fax and Mail Reports to; Recipient 3 (Name and Company): Person and company where prelim and/or final copy of analytical results are to be sent if to more than one
14. Recipient 1 (Address, Tel No., and Fax No.): Address, phone number and fax number of where prelim is to be faxed and final analytical results are to be sent
15. Recipient 2 (Address, Tel No., and Fax No.): Address, phone number and fax number of where prelim is to be faxed and final analytical results are to be sent if more than one

16. Recipient 3 (Address, Tel No., and Fax No.): Address, phone number and fax number of where prelim is to be faxed and final analytical results are to be sent if more than one

17. Item (numbered 1 through 10): to be used when relinquishing samples

18. Sample Identifier: Specific sample number for each <u>sample</u> NOT FOR EACH BOTTLE. For QC samples such as trip blanks, use TB-sample date-number (1, 2, 3...if more than one trip blank on that sample date).

19. Sample Description/Location: Describe sample and where it was collected (confirmation soil collected at NW wall of excavation A **or** groundwater sample collected at MW3 at OWS 13 **or** soil boring collected at 2′ interval at OWS 13)

20. Matrix: Soil, Sediment, Water, Oil, Product, Vapor, Wipe, etc.

21. Date Collected: What day was sample collected

22. Time Collected: What time was sample collected (24-hour clock)

23. Data Package Level: CCI Data Package Level (A, B, or C)

24. TAT (Calendar Days): Place turn-around-time in days for when preliminary results are due

25. Analyses Required (Include Method Numbers): List one analysis per column and include method number (will be listed in Sampling and Analysis Plan) (TCL VOCs by 8260B)

26. Sample Type: Field, QC, Grab, Composite (include all applicable descriptions; e.g. Field Grab

27. Comments/Screening Readings: Place any comments here, for example, “strong organic odor.” Also if soil was screened before sent to lab, place screening results here.

28. Lab ID: Leave this blank, this is for lab’s use.

29. Sampler(s) and Company: ALL samplers’ names and companies here.

30. Courier and Shipping Number: Put name of shipping company and airbill number(s) here. Include ALL airbill numbers. (Fed Ex #: 123456789, 987654321, 132435465)

31. Samples Temp and Conditions Upon Receipt: Leave blank, lab will fill in.

32. Relinquished by: Sign and print name and place date and time here. Date should be on or after date collected. (See the SOP for custodial instructions)

33. Received by: Sign and print name and place date and time here. (See the SOP for custodial instructions)

Attachment 4: HSE Self-Assessment Checklist

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Attachment 4: HSE Self-Assessment Checklist

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HS&E Self-Assessment Checklist –Waste Management: Analysis and Characterization

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI. This checklist is to be used at locations where: (1) CH2M HILL employees will be managing wastes generated on project sites and/or (2) CH2M HILL provides oversight of subcontractor personnel who are managing wastes generated at project sites.

CH2M HILL staff shall not direct the means and methods of subcontractor waste management activities nor direct the details of appropriate corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

The Safety Coordinator (SC) may consult with subcontractors when completing this checklist, but shall not direct the means and methods of waste characterization, sampling and analysis operations nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Completed checklists shall be sent to the HS&E Staff for review.

Project Name: ____ Project No.: ____________________

Location: ____ PM:

Auditor: _________________________________ Title: __________________________ Date: _____________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL compliance with its Waste Management: Analysis and Characterization program (SOP HSE-408)

☐ Evaluate a CH2M HILL subcontractor's compliance with its waste management program

Subcontractors Name: ____

- Check "Yes" if an assessment item is complete/correct
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable
- Check "N/O" if an item is applicable but was not observed during the assessment

SECTION 1

	Yes	No	N/A	N/O
GENERAL WASTE CHARACTERIZATION INFORMATION (5.1)				
COMPLIANCE PROGRAM (5.1.1)				
1. Personnel told not to sign waste documentation (e.g., manifests) unless specifically authorized by the client in writing.	☐	☐	☐	☐
2. Waste characterized before it is generated.	☐	☐	☐	☐
3. Waste characterized by Client using generator information	☐	☐	☐	☐
4. Waste stream characterization documented in project file.	☐	☐	☐	☐
5. Waste volumes estimated.	☐	☐	☐	☐
6. Disposal facility sampling and analytical requirements identified.	☐	☐	☐	☐
WASTE SAMPLING AND ANALYSIS (5.2)				
IDENTIFY ANALYTICAL TEST METHODS (5.2.1)				
7. Nature and quantity of the waste determined.	☐	☐	☐	☐
8. Analyses required for transport, treatment and disposal determined.	☐	☐	☐	☐
9. Detection limits identified.	☐	☐	☐	☐
10. Disposal facility provided with analytical results.	☐	☐	☐	☐
11. Analytical test methods identified.	☐	☐	☐	☐

	Yes	No	N/A	N/O
SAMPLING (5.3)				
12. A sampling plan is developed.	☐	☐	☐	☐
13. Field activities are recorded in a logbook.	☐	☐	☐	☐
14. Exceptions to sampling plan documented in field logbook.	☐	☐	☐	☐
Sample Labels (5.3.1)				
15. The sample is in custody.	☐	☐	☐	☐
16. Each container labeled with project name, number, sample ID number, date and time.	☐	☐	☐	☐
17. The label on the container is covered with clear tape to prevent loss.	☐	☐	☐	☐
Custody Seals (5.3.4)				
18. Sample shipping containers sealed with two custody seals.	☐	☐	☐	☐
19. Custody seals placed over the left and right sides of the container's cover (cooler).	☐	☐	☐	☐
20. Each seal signed and dated with time.	☐	☐	☐	☐
21. Seals are covered with clear tape to prevent loss.	☐	☐	☐	☐
22. Custody seals placed on sample container immediately after collection.	☐	☐	☐	☐
23. Custody seals must be placed in a manner that they must be broken to open sample container.				
CHANGE OF CUSTODY FORM INSTRUCTIONS (5.3.5)				
24. Chain of Custody form completed per instructions.	☐	☐	☐	☐
RECORDS (5.3.6)				
25. Official copy of COC form sent to the project chemist and lab with sample shipment.	☐	☐	☐	☐
26. Original COC submitted to the lab along with final data packages.	☐	☐	☐	☐
27. Changes to analytical requests on COC form or the PO made in writing to the lab.	☐	☐	☐	☐
28. A copy of written change sent to PM, lab and placed in project files.	☐	☐	☐	☐
29. Reasons for change are included in sample log and project file.	☐	☐	☐	☐
30. Sample logbooks, sample logs, and COC forms sent to PM at completion of project activities.	☐	☐	☐	☐

SECTION 3 Complete this section for all items checked "No' in Sections 1 or 2. Deficient items must be corrected in a timely manner.		
Item #	**Corrective Action Planned/Taken**	**Date Corrected**

Auditor: _________________________________ Project Manager: _________________________

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CLICK HERE FOR ATTACHMENTS

Waste Management: Non-Hazardous Waste
Enterprise Standard Operating Procedure HSE-411

1.0 Purpose

This Enterprise Standard Operating Procedure (SOP) describes the management practices associated with non-hazardous waste. Waste management includes storage, transportation, and disposal of waste. It is designed to be used in conjunction with HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization and applies to field projects as well as office and warehouse wastes.

2.0 Scope and Application

2.1 Scope

Non-hazardous wastes are generally subject to solid waste management requirements. Other wastes that are not hazardous but are subject to regulation include asbestos waste (see HSE-502), PCB waste (see HSE-412), and lead-contaminated waste (see HSE-508). However, non-hazardous waste may be more stringently regulated by a state or local entity. Consult the Responsible Environmental Manger to determine state or local management standards.

2.2 Application

This SOP applies Enterprise Wide to all CH2M HILL Legal Entities and Business Groups, their employees, subcontractors and their lower-tier subcontractors that operate in the United States (US) and internationally.

Some state environmental or OSHA programs may have more stringent requirements. . State regulations may be found under Regtools. Contact the appropriate Responsible Environmental Manager (REM) to address these specific requirements. This SOP should be used as a starting point for international operations, but country-specific health, safety and environmental (HSE) regulations shall prevail, and a country-specific SOP should be developed to comply with these specific HSE regulations.

2.3 Applicable Enterprise SOPs

Applicable Enterprise Standards of Practice and Standard Operating Procedures that are applicable to this Waste Management-Non Hazardous Waste SOP are as follows:

- HSE-408, Waste Management Analysis and Characterization
- HSE-409, Waste Management
- HSE-412, PCB Waste
- HSE-413, Waste Management Planning
- HSE-415, Universal Waste
- HSE-502, Asbestos Waste
- HSE-508, Lead-contaminated Waste

3.0 Definitions

3.1 Asbestos-Containing Material (ACM)

Asbestos-containing materials are materials that contain asbestos that may be generated from construction, demolition or renovation of structures where asbestos is present; or removal of materials containing asbestos.

3.2 Characterization

Characterization is the process performed by a generator to determine the type of waste being managed and how the waste should be disposed. This process can involve identifying waste constituent concentrations and comparing the concentrations to legal requirements or threshold levels that affect how the waste is disposed. Waste characterization procedures are provided in the HSE-408, Waste Management Analysis and Characterization.

3.3 Construction and Demolition (C&D) Debris

Construction and demolition (C&D) debris is waste material that is produced in the process of construction, renovation or demolition of structures. Structures can include buildings, bridges, slabs, and pavements. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Note that some states have separate regulatory requirements for C&D waste.

3.4 Lead-contaminated Waste

Lead-contaminated wastes are wastes that contain lead (e.g., old paint containing lead). Such wastes may be generated during construction, demolition, or renovation of structures. HSE-508, Lead-contaminated Waste, discusses managing lead-contaminated materials

3.5 Non-Hazardous Waste

In this SOP, non-hazardous wastes are considered to be wastes that are not classified as hazardous under RCRA Subtitle C and are not subject to other regulatory requirements (e.g., PCB, asbestos).

3.6 National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) permit program regulates the point source discharge of industrial wastewater and storm water.

3.7 Publicly Owned Treatment Works (POTW)

Publicly-owned treatment works (POTW), owned by a state or municipality, are used to treat (including recycle and reclaim) either domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature. If owned by a federal agency (e.g., Department of Defense), this is called a federally-owned treatment works (FOTW).

3.8 Purge Water

Purge water is removed from a well prior to the collection of a groundwater sample to make sure that the sample is representative of groundwater in the aquifer and not stagnant water within the well.

3.9 Petroleum-Contaminated Soil

Petroleum-contaminated soil refers to soil that may be contaminated with petroleum as a result of leaky underground storage tanks or some other source.

3.10 PCB Wastes

Most PCB wastes that are encountered are generated from management of PCB-containing equipment (e.g., light ballasts), clean up and remediation of PCB-contaminated soils. This also includes PCB articles—any PCB item, PCB container, PCB equipment, or anything that deliberately or unintentionally contains PCBs.

3.11 Solid Waste

For purposes of this SOP, solid wastes are generally non-hazardous wastes that do not contain any regulated constituents such as solvents, lead, and PCBs.

3.12 Stockpiles

A stockpile is an area where soil or debris is consolidated and stored or managed in a pile.

3.13 Underground Injection Control (UIC)

The Underground Injection Control (UIC) Program refers to the Environmental Protection Agency (EPA) program responsible for monitoring subsurface wastewater discharges.

3.14 Universal Waste

Universal waste is hazardous waste that is regulated by EPA or state jurisdictions having authority over hazardous waste regulation. If managed as universal waste, these hazardous wastes are subject to less stringent management procedures. These wastes currently include batteries, agricultural pesticides, mercury-containing thermostats, and lamps.

3.15 Well Development Water

Well development waster refers to water that is circulated through the well screen and well bore to remove settled and suspended materials within the well, which increases the permeability of the formation surrounding the well screen.

4.0 Roles and Responsibilities

4.1 Project Manager (PM)

The PM is responsible for ensuring that non-hazardous wastes are managed in accordance with this SOP. The PM should work with the Responsible Environmental Manager (REM) to identify good management practices and comply with any local requirements affecting non-hazardous or solid wastes.

4.2 Responsible Environmental Manger (REM)

The REM assists the project manager in ensuring that the project complies with the environmental laws and regulations by identifying issues and resources to meet project needs.

4.3 Safety Coordinator (SC)

The SC is familiar with project plans, including air emission controls and permit conditions, and implements the plans in the field.

5.0 Procedures

CH2M HILL requires managing non-hazardous wastes in accordance with good management practices.

5.1 Waste Characterization and Management

To assure proper management and disposal, it is necessary to determine the type of waste that needs to be managed. Refer to HSE-408, Waste Management Analysis and Characterization for waste characterization procedures. The following wastes are subject to other requirements that are discussed in the corresponding SOP:

- **Asbestos**—Refer to HSE-502. Asbestos-containing wastes must be double-bagged and placed in landfill cells permitted to accept asbestos-containing wastes.
- **PCBs**—Refer to HSE-412.
- **Universal Waste**—Refer to HSE-415. If universal waste is not managed according to the universal waste regulatory requirements, it is considered hazardous waste and would need to be managed as discussed in HSE-409.

Some states and local agencies require that petroleum-contaminated soil be managed in a more stringent manner, and may even require that it be managed as hazardous waste. Consult the REM for state and local requirements.

For all waste streams, CH2M HILL's order of preference for waste management is source reduction, recycling, and lastly disposal.

5.1.1 Source Reduction

Source reduction is defined as the design, manufacture, and use of products to reduce the quantity and toxicity of waste produced when the products reach the end of their useful lives. Source reduction activities fall into some basic categories:

- Product reuse (e.g., reusable shopping bags and coffee mugs)
- Reduced material volume (e.g., less unnecessary packaging for products)
- Reduced toxicity of products (e.g., use substitutes for lead, cadmium, mercury, and other toxins)
- Increased product lifetime (e.g., design products with longer useful life)
- Decreased consumption (e.g., changing consumer buying practices, bulk purchasing).

These source reduction practices reduce cost and amount of waste management practices.

5.1.2 Recycling

A variety of office and project wastes can be recycled. Check with your REM to see what markets are available in your area.

5.1.3 Office Recycling

The following materials are recycled at CH2M HILL offices:

- Aluminum cans
- Corrugated cardboard
- Laser printer cartridges
- Newspaper
- Office paper
- Magazines
- Telephone books
- Lead-acid batteries
- Selected plastics

5.1.4 Project Recycling

In addition to the office recyclables that are generated on project sites, the following project materials should also be recycled:

- Asphalt
- Concrete
- Insulation
- Scrap metal
- Petroleum-contaminated soil
- Carbon filters

5.2 Storage

The storage of solid waste (including items that may be recycled, e.g., petroleum-contaminated soil) may be subject to state or local requirements. Consult your REM for assistance.

5.2.1 Stockpiles

Solid waste stockpiles are typically regulated by state and local agencies. Technical standards may include storing the wastes on plastic sheeting and covering with plastic. Some states require permits for solid waste stockpiles. States may also have time limits for solid waste stockpiles and dust control requirements. Consult your REM for assistance.

5.2.2 Containers

Solid waste containers should meet DOT specifications. State and local agencies may also have specific requirements for solid waste containers. Consult your REM for assistance.

5.2.3 Labels

Use the following label for containers of non-hazardous waste. The non-hazardous waste label and other labels can be ordered by phone or online through Mesa Label Express (www.mesalabel.com; 858-693-4987) or Labelmaster (www.labelmaster.com; 800-621-5808).

5.3 Disposal

Non-hazardous wastes are subject to regulation as solid waste. Consult your REM for assistance. The following subsections discuss management of typical non-hazardous wastes generated at CH2M HILL project sites.

5.3.1 Construction and Demolition (C&D) Debris

Demolition debris can be hauled, and then dispensed at any construction and demolition (C&D) landfill or any municipal solid waste landfill that is permitted to accept C&D debris. C&D debris should be reduced whenever possible. Clean C&D debris can be reused, such as broken concrete without protruding metal bars, bricks, rock, stone, reclaimed asphalt pavement, dirt or sand. Additionally, there are a number of C&D debris recyclers that will accept wood, aluminum and other metals, asphalt, concrete, and corrugated cardboard. If debris is known to contain hazardous substances, review HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization to determine the appropriate procedures for disposal.

5.3.2 Lead-Contaminated Waste

If lead-based paint debris from abatement, deleading, renovation, remodeling, and demolition contains more than 5 mg/L of lead (determined by knowledge of the waste or TCLP tests), the debris may be subject to RCRA subtitle C hazardous waste requirements. For RCRA requirements and procedures, refer to HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization. EPA has proposed a rule to exclude lead-based paint from regulation as hazardous waste, although it is regulated under the Toxic Substances Control Act (TSCA).

5.3.3 Petroleum-Contaminated Soil

Petroleum-contaminated soil is generated from spilled petroleum compounds, often from leaky underground storage tanks. The soil can be treated, disposed of, recycled, and reused in many different manners. Typical strategies that have been used to manage petroleum-contaminated soil include: use of the petroleum-contaminated soil as a landfill cap, removal of the petroleum through soil treatment with Low-Temperature Thermal Desorption (LTTD), and soil land farming to break down the petroleum products with reuse onsite.

LTTD has proven very effective in reducing concentrations of petroleum products including gasoline, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils. Operation of LTTD units at a project site requires various permits and demonstration of compliance with permit requirements. Monitoring of LTTD system waste streams (*e.g.*, concentrations of particulates, volatiles, and carbon monoxide in stack gas) are required by the agency(ies) issuing the permits for operation of the facility. Each state has its own standards for soil cleanup levels. Contact your REM for assistance as soil and air monitoring may be required.

5.3.4 Well Purge and Development Water

There are four options for the disposal of well purge and development water generated at project sites:

1. Onsite treatment and discharge
2. Discharge to POTW/FOTW
3. Discharge to injection galleries/injection wells
4. Discharge to ground

Note that discharge to surface water is not an option. A discharge to surface water would require an NPDES permit.

Onsite Treatment and Discharge

Non-hazardous well purge/development water may be treated with an existing groundwater treatment system that has an NPDES permit or POTW approval. It can also be discharged to the sewer without treatment if the POTW grants approval and the POTW's influent criteria are met. Purge water can also be discharged to an onsite wastewater pretreatment system operated by the facility owner, providing it does not affect the discharge from the pretreatment system.

Hazardous purge/well development water can also be treated onsite in a treatment system without a hazardous waste treatment permit if the treatment system can be defined as a wastewater treatment unit under RCRA (40 CFR 264.1 (g)(10)). To do so, the following criteria must be met:

1. The treatment unit has an NPDES permit under the Clean Water Act (CWA), or discharges to a POTW via sewer or direct connection, under a permit or written approval;

2. The treatment unit receives and treats (or stores) influent wastewater, which might be hazardous; and

3. The treatment unit meets the definition of a *tank* or *tank system*.

If discharged to a POTW, the water is no longer defined as a "solid waste" under RCRA once it is in the sewer because it is regulated under the CWA.

In addition to the above, the water should originate from wells at the site and not from other sites; i.e., from the same aquifer. Do not treat water from offsite sources unless instructed by the client in writing, and only after receiving EPA or state approval.

Although treatment devices, such as carbon canisters, air strippers, and oil/water separators are often considered a tank or tank system, these definitions are subject to state and local regulatory interpretation. Waste residues, e.g., filter bags, and tower packing, from water treatment are not exempt from the RCRA regulations and must be tested to determine if they are a hazardous waste.

Discharge at Offsite POTW/FOTW

Hazardous and non-hazardous well purge/development water may be discharged at an offsite POTW under the following conditions:

1. The discharged water is properly classified, using "client" knowledge and/or testing;
2. The water must *not* be ignitable and must not have a sheen or film of separate-phase oil or other organics;
3. A written notice, signed by the client, is submitted to the POTW, and the water meets the POTW acceptance limits (the client determines this);
4. Approval from the POTW is received *in writing*; and
5. For hazardous waste shipments to POTWs, federal regulations in 40 CFR 270.1(c)(2)(v) also require the POTW to:
    - Have an EPA ID number;
    - Request use of a Hazardous Waste Manifest for the shipment;
    - Report manifest discrepancies;
    - Submit Biennial and unmanifested waste reports; and
    - The waste must meet pre-treatment requirements.

This is not a preferred option. It is also impractical because it is difficult to find a POTW that will accept RCRA or state hazardous wastes. If a POTW is used, document the shipment with a shipping paper or manifest, and make arrangements for transportation with a transporter approved for use by CH2M HILL and the client.

Discharge to Injection Galleries/Injection Wells

Discharge of well purge/development water to an injection gallery or injection well is allowed by permit or approval. The purge water must originate from wells at the site, i.e., from the same aquifer, and have the same chemical properties as that approved for re-injection. The criteria below must be met:

1. The water is non-hazardous or is exempt from hazardous waste regulations under 40 CFR 261.4(a) &(b); and
2. The injection gallery at the client site is operating under a state permit, or approval from the EPA Regional Underground Injection Control (UIC) Coordinator; or
3. For CERCLA Sites, if the water is hazardous and is discharged to an injection gallery or injection well constructed within a designated area of contamination, the agency will likely establish discharge limits, and monitoring/reporting requirements through the state UIC or wastewater discharge program.

Discharge to Ground Surface

Discharge of purge water to ground surface is allowable under the following conditions:

1. The discharged water is properly classified, using client knowledge and/or testing;
2. The water is *not* a RCRA or state hazardous waste;
3. Written approval is received from the client; and
4. Discharge is performed under state permit or approval, or state guidelines.

States often require that purge water be filtered with carbon prior to discharge to ground surface. Portable handcart-mounted adsorption units are available from a number of vendors such as Continental Environmental Systems (800-342-1103). Remember that a container of granular activated carbon (GAC) that shows signs of "breakthrough" is considered "spent" and must be managed as a waste and must be characterized under procedures discussed in the Waste Management Analysis and Characterization SOP (HSE-408).

6.0 Training Requirements

Employees on projects that generate waste must complete the following training:

- Dangerous Goods Training
- Environmental Awareness Training
- Waste Management Training

7.0 Checklists

The HSE Self Assessment Checklist: Non Hazardous Waste Management in Attachment 1 is provided as a method for verifying compliance with this SOP. The REM specifies the frequency in which this checklist shall be completed by the SC and provides this information in the project's written safety plan. The REM shall assist the SC in resolving any deficiencies identified during the self assessment. The REM may also use this checklist when performing HS audits at CH2M HILL projects, including subcontractor's activities.

8.0 References

The following regulations were referenced to prepare this Enterprise Standard Operating Procedure:

- US Environmental Protection Agency (EPA): 40 CFR Parts 260 through 279, Resource Recovery and Conservation Act (RCRA)

9.0 Attachments

Attachment 1: **HS&E Self Assessment Checklist: Non-Hazardous Waste**

10.0 Approval

Revision	Date	Prepared By	Approved By:
1.0	10-08-2007	Jim Kelly	

CH2MHILL

Attachment 1: HSE Self-Assessment Checklist

CH2MHILL

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI. This checklist is to be used at locations where CH2M HILL generate or manage non-hazardous waste.

CH2M HILL staff shall not direct the means and methods of subcontractor activities nor direct the details of appropriate corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________
Location: ______________________________ PM:
Auditor: ____________________ Title: __________________ Date: __________
This specific checklist has been completed to:
☐ Evaluate CH2M HILL compliance with its Non-Hazardous Waste SOP (HSE-411)
☐ Evaluate a CH2M HILL subcontractor's compliance with non-hazardous waste procedures.
Subcontractors Name: ______________________________________

- Check "Yes" if an assessment item is complete/correct
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable
- Check "N/O" if an item is applicable but was not observed during the assessment

SECTION 1

	Yes	No	N/A	N/O
PROCEDURES				
SOURCE REDUCTION AND RECYLCING (5.1.1)				
1. Products have been re-used to reduce waste quantity and toxicity	☐	☐	☐	☐
2. Material volumes have been reduced by less packaging.	☐	☐	☐	☐
3. Less toxic products have been used to reduce waste toxicity.	☐	☐	☐	☐
4. Materials at CH2M HILL offices are recycled.	☐	☐	☐	☐
5. Recyclables generated at project sites are recycled.	☐	☐	☐	☐
STORAGE (5.2)				
6. Local or state solid waste storage requirements have been identified.	☐	☐	☐	☐
7. Local and state solid waste stockpile requirements have been identified.	☐	☐	☐	☐
8. Solid waste containers meet DOT specifications.	☐	☐	☐	☐
9. Non-hazardous waste label used for containers of non-hazardous waste.	☐	☐	☐	☐
DISPOSAL (5.3)				
Construction and Demolition Debris (5.3.1)				
10. Construction debris is disposed of at a landfill permitted to take C&D debris.	☐	☐	☐	☐
11. Clean C&D debris is reused.	☐	☐	☐	☐
12. C&D debris considered for recycling.	☐	☐	☐	☐
13. C&D debris containing hazardous waste is managed under HSE-408.	☐	☐	☐	☐

HS&E Self-Assessment Checklist –Non-Hazardous Waste

	Yes	No	N/A	N/O
Lead-Contaminated Waste (5.3.2)				
14. Lead-based paint debris managed under HSE-408 and HSE-413.	☐	☐	☐	☐
Petroleum-Contaminated Soil (5.3.3)				
15. REM consulted for treatment, disposal and recycling options for petroleum-contaminated soils.	☐	☐	☐	☐
Well Water Onsite Treatment and Discharge				
16. Non-hazardous well purge/development water treated in existing NPDES-permitted system.	☐	☐	☐	☐
17. Non-hazardous water is discharged to sewer untreated with POTW approval.	☐	☐	☐	☐
18. Non-hazardous waste is discharged to onsite wastewater pretreatment system.	☐	☐	☐	☐
19. Treatment of hazardous wastewater meets requirements of RCRA wastewater treatment unit.	☐	☐	☐	☐
Discharge at Offsite POTW/FOTW (5.3.4)				
20. Discharged water is classified using “client” knowledge and/or testing.	☐	☐	☐	☐
21. The water is not ignitable, does not contain organics or have an oily sheen.	☐	☐	☐	☐
22. Client provided written notice to POTW that water meets acceptance limits.	☐	☐	☐	☐
23. POTW discharge approval received in writing.	☐	☐	☐	☐
24. POTW EPA ID number obtained for hazardous wastewater.	☐	☐	☐	☐
25. Hazardous waste manifest used for transport of hazardous waste to POTW.	☐	☐	☐	☐
26. Waste meets pre-treatment requirements	☐	☐	☐	☐
Discharge to Injection Galleries/Injection Wells (5.3.4)				
27. Permit or approval obtained for discharge to injection gallery or well.	☐	☐	☐	☐
28. Purge water originated from wells at the site (same aquifer with same chemical properties).	☐	☐	☐	☐
29. The purge water is non-hazardous or exempt from hazardous waste regulations.	☐	☐	☐	☐
30. Injection gallery at site is operating under state permit or approval from EPA.	☐	☐	☐	☐
Discharge to Ground Surface (5.3.4)				
31. Discharged water is classified using “client” knowledge and/or testing.	☐	☐	☐	☐
32. Purge water is not a RCRA or state hazardous waste.	☐	☐	☐	☐
33. Written approval received from the client.	☐	☐	☐	☐
34. State permit or approval received for discharge.	☐	☐	☐	☐
35. Carbon filtration used prior to discharge to the ground surface.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked “No’ in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: _________________________

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

To provide general guidelines for entering field data into log books during site investigation and remediation field activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement of much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, orange-covered logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.
2. On the inside cover of the log book the following information should be included:
   - Company name and address
   - Log-holders name if log book was assigned specifically to that person

- Activity or location
- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have a the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Talks: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data

obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
    - Parameters to be analyzed for, if appropriate
    - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature (e.g., Horiba® U-22 or similar)
- Water-level indicator
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Generator
- Disposable polyethylene tubing
- Plastic sheeting
- Well-construction information
- Calibrated bucket or other container and watch with second indicator to determine flow rate
- Sample containers
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.

2. Instruments are calibrated according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with SOP *Water Level Measurements*. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well installation log.

7. Attach and secure the polyethylene tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake at least 2 feet above the bottom of the well to avoid mobilization of any sediment present in the bottom. Preferably, the pump should be in the middle of the screen.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

10. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.5-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.

11. During purging, the field parameters are measured frequently (every 3 to 5 minutes) until the parameters have stabilized. Field parameters are considered stabilized when measurements meet the following criteria:

    - pH: within 0.1 pH units
    - Specific conductance: within 3 percent

- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent or as low as practicable given sampling conditions
- ORP: within 10 mV

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the logbook:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; whether the sample is filtered or not; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45-micron filter) using the pressure provided by the pumping device for its operation.

4. Samples for analysis for volatile organic compounds should be collected first, if such samples are required.

5. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.

6. The bottle is capped, then labeled clearly and carefully following the procedures in SOP *Packaging and Shipping Procedures*.

7. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. It may not be possible to prevent drawdown in the well if the water-bearing unit has sufficiently low permeability. If the water level was in the screen to start with, do not worry about it because there is no stagnant water in the riser above the screen to begin with.

   If the water level in the well is in the riser above the screen at the beginning of purging, then be sure you pump out sufficient volume from the well to remove the volume of water in the riser above the screen. For a 2-inch diameter well, each foot of riser contains 0.163 gallons; for a 4-inch riser, each foot of riser contains 0.653 gallons; for a 6-inch riser, each foot of riser contains 1.47 gallons.

   Alternatively, the water in the riser above the screen can be removed by lowering the pump into the well until the pump intake is just below the water level, starting the pump, running it at a low rate, and slowly lowering the pump as the water level in the riser declines. This approach can be terminated when the water level reaches the top of the screen, at which time the stagnant water in the riser has been removed. This may not be a practical approach for dedicated sampling equipment. As with typical low-flow sampling, the flow rate should be kept as low as practicable.

3. There may be circumstances where a positive-displacement or submersible pump cannot be used. An example is at isolated, hard-to-reach locations where the required power supply cannot be brought. In this case, a peristaltic pump may be used. Samples can be collected by the procedures described above for all but those for VOC analysis. The water to be placed in the vials for VOC analysis should not be run through the peristaltic pump but instead should be collected by the following:

   - Stop the pump when it is time to collect the VOC sample.

- Disconnect the tubing upstream from the pump (a connector must be installed in the line to do this).
- Pinching the tubing to keep the water in the tubing, remove the tubing from the well. Be sure that the tubing does not contact other than clean surfaces.
- Place the end of the tubing that was in the well into each VOC vial and fill the vial by removing the finger from the other end of the tube.
- Once the vials are filled, return the tubing to the well and collect any other samples required.

4. Nondedicated sampling equipment is removed from the well, cleaned, and decontaminated in accordance with SOP *Decontamination of Personnel and Equipment*. Disposable polyethylene tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - Inspect sampling pump regularly and replace as warranted
    - Inspect quick-connects regularly and replace as warranted
    - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

Preserving Non-VOC Aqueous Samples

I. Purpose

To provide general guidelines for preserving aqueous samples.

II. Scope

Standard aqueous sample preservation procedures for non-VOC samples are provided.

III. Equipment and Materials

- Disposable eye droppers
- Clean beakers for transfer of small portions of chemical preservative
- pH paper strips (range 0 to 14)
- Chemical preservatives, as appropriate
- Personal protection, as appropriate
- Clean out door or vented indoor area

IV. Procedures and Guidelines

1. Remove caps from sample containers to be chemically preserved in designated area. Add appropriate amount of chemical preservative to opened container. To determine the approximate amount of preservative required, preserve a sample of potable water and calculate the volume of preservative required.

2. After adding the appropriate preservatives to the sample containers, cap containers tightly. Invert sample container a few times to mix.

3. After preserving all the sample containers and mixing, open the container and check the pH of the sample by pouring out a small quantity of the sample to a clean receptacle and dipping a pH indicating strip into the sample. Add more preservative to the sample to adjust the pH, if necessary repeating steps 1 and 2. When three times the amount of preservative used to preserve a sample of potable water has been added, record the pH and notify the sample manager that the sample could not be preserved.

V. Attachments

None.

VI. Key Check Items

Be sure appropriate preservatives are used.

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		Applicability: B&R Environmental, NE	
		Prepared: Risk Assessment Department	
Subject: SAMPLE NOMENCLATURE		Approved: D. Senovich	

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1.0 PURPOSE

The purpose of this document is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix.
- Sorting of data by depth.
- Maintenance of consistency (field, laboratory, and data base sample numbers).
- Accommodation of all project-specific requirements on a global basis.
- Accommodation of laboratory sample number length constraints (10 characters).

2.0 SCOPE

The methods described in this procedure shall be used consistently for all projects requiring electronic data handling managed by personnel located in the Northeast Region of Brown & Root Environmental (Pittsburgh, Wayne, Holt, and Wilmington) and for any large contracts managed by the Northeast Region (e.g., NORTHDIV CLEAN, SOUTHDIV CLEAN, ARCS I, ARCS III, etc.). Smaller projects (as determined by Project Manager) are outside the scope of this SOP.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Program Manager - It shall be the responsibility of the Program Manager (or designee) to inform contract-specific Project Managers of the existence and requirements of this Standard Operating Procedure.

Project Manager - It shall be the responsibility of the Project Manager to determine the applicability of this Standard Operating Procedure based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the sample nomenclature is thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and is consistent with this Standard Operating Procedure if relevant. It shall be the responsibility of the project manager to ensure that the Field Operations Leader is familiar with the sample nomenclature system.

Field Operations Leader - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians or sampling personnel are thoroughly familiar with this Standard Operating Procedure and the project-specific sample nomenclature system. It shall be the responsibility of the Field Operations Leader to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

5.0 PROCEDURES

5.1 Introduction

The sample numbering system consists of 12 distinct alpha-numeric characters, only 10 of which will be provided to the laboratory on the sample labels and chain-of-custody forms. The sample number provided to the lab shall be as follows where "A" indicates "alpha," "N" indicates "numeric," and "E" indicates "either"):

$$\overline{E}\ \overline{E}\ \overline{E}\ \overline{A}\ \overline{A}\ \overline{E}\ \overline{E}\ \overline{E}\ \overline{N}\ \overline{N}$$

Once the analytical results are received from the laboratory the sample number will be revised by a subroutine such that the sample number is more user friendly (i.e., dashes will be inserted). The sample number will then appear as follows:

$$\overline{E}\ \overline{E}\ \overline{E} - \overline{A}\ \overline{A} - \overline{E}\ \overline{E}\ \overline{E} - \overline{N}\ \overline{N}$$

If multiple sampling events occur (or are planned) for a given matrix, a subroutine within the database will be used to append two additional characters such that the sample number will appear as follows:

$$\underbrace{\overline{E}\ \overline{E}\ \overline{E}}_{\text{Site}} - \underbrace{\overline{A}\ \overline{A}}_{\text{Type}} - \underbrace{\overline{E}\ \overline{E}\ \overline{E}}_{\text{Location}} - \underbrace{\overline{N}\ \overline{N}}_{\text{Depth}} - \underbrace{\overline{N}\ \overline{N}}_{\text{Round}}$$

5.2 Sample Number Field Requirements

The various fields in the sample number will include the following:

- Site Identifier
- Sample Type
- Sample Location
- Sample Depth Indicator
- Sampling Round

The site identifier must be a three-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary since many facilities/sites have multiple individual sites, SWMUs, operable units, etc.

The sample type must be a two-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be a three-character field (alpha, numeric, or a mixture).

The depth field must be provided for all samples, regardless if it is strictly applicable (as discussed in Section 5.3).

The sampling round is optional, but, if provided, must be two numeric characters.

5.3 Example Sample Field Designations

Examples of each of the fields are as follows:

Site Number - Examples of site numbers/designations are as follows:

A01 - Area of Concern Number 1
125 - Solid Waste Management Unit Number 125
000 - Base or Facility Wide Sample (e.g., upgradient well)
BBG - Base Background

The examples cited are only suggestions. Each Project Manager (or designee) must designate appropriate (and consistent) site designations for their individual project.

Sample Type - Examples of sample types are as follows:

AS - Air Sample
BS - Biota Sample (See Note)
CP - Composite Sample
CS - Chip Sample
DS - Drum Sample
DU - Dust Sample
FP - Free Product
ID - Investigation Derived Waste Sample
LT - Leachate Sample
MW - Monitoring Well
OF - Outfall Sample
RW - Residential Well Sample
SB - Soil Boring Sample
SD - Sediment Sample
SC - Scrape Sample
SG - Soil Gas Sample
SP - Seep Sample
SS - Surface Soil Sample
SU - Subsurface Soil Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WI - Wipe Sample
WP - Well Point Sample
WS - Waste/Sludge Sample

Note: The biota sample designation may be contingent upon the type of biota sampled (e.g., BL - Lobster; BF - Finfish; BC - Clam; BO - Oyster). Numerous other examples can be cited but will be site-specific.

This field will also be used to designate field Quality Control Samples, as follows:

TB - Trip Blank
FB - Field Blank
RB - Rinsate Blank (Equipment Blank)
BB - Bottle Blank
AB - Ambient Condition Blank

Field quality control samples should be numbered sequentially (e.g., RB-001; FB-010, etc.).

Filtered/unfiltered surface water or groundwater samples shall be handled in an separate manner, as subsequently discussed.

Location - Examples of the location field are as follows:

A01 - Grid node A1
001 - Monitoring Well 1

It is important that consistency be maintained with respect to the use of the characters "0" and O. Data base subroutines will not sort correctly if a mixture are used (e.g, AO1 and A02).

Depth - Formerly, depth specifications were indicated with a four digit field (e.g., 0002 - 0 to 2 feet). While this is effective for depth sorting, it is difficult to include this level of detail in a 10-character lab number (FormMaster limitations). In addition, this approach will not accommodate non-integer depths (e.g., 2.5 feet to 4.5 feet).

Based on such potential problems, the following approach shall be used: Sample depths will simply represent the horizon from which the sample was obtained: For example, if ten split-spoon samples are collected from a boring, they will be numbered 01 through 10. The sample log sheet will be used to record the specific depth of the sample, and this information will be entered in a separator field in the data base.

Similar nomenclature will be used for depth-specific surface water and sediment samples, etc. If no depth information is required (e.g., groundwater samples), the field must still be filled (e.g., Ø, Ø).

This field will also be used for the designation of filtered and unfiltered samples. An unfiltered groundwater sample shall be designated as U0, if and only if, a corresponding filtered sample is collected. Such as sample shall be designated as F0.

Sampling Round - The sampling round field is straightforward. It can range from 01 to 99.

5.4 Example Sample Numbers

Examples of complete sample numbers (field/data base versus laboratory) are as follows:

Field/Data Base ID	Lab ID	Description
101-SB-A01-01	101SBA0101	The first sample (e.g., 0 to 2 feet) from soil boring A01 (grid) at Site 101.
101-SB-A01-02	101SBA0102	The second sample from boring A01 (could be the next depth interval or a duplicate of 101-SB-A01-01).
125-MW-001-01-01	125MW00101	A groundwater sample from monitoring well MW001 (first sampling round)
125-MW-001-02-01	125MW00102	A duplicate groundwater sample from monitoring well MW001 (first sampling round)
130-MW-003-U1-01	130MW003U1	An unfiltered groundwater sample from monitoring well MW003 (first sampling round)
130-MW-003-F1-01	130MW003F1	A filtered groundwater sample from monitoring well MW003 (first sampling round)
137-RB-001-00-01	137RB00100	The first rinsate blank collected at site 137.
137-TB-004-00-02	137TB00400	The fourth trip blank collected during the second sampling event at Site 137.
155-SW-003-01-01	155SW00301	A surface water sample collected from the surface of a pond at Site 155.
155-SW-003-02-01	155SW00302	A surface water sample collected from the bottom of the water column in a pond at Site 155.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. The sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

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		Prepared Earth Sciences Department	
Subject SOIL AND ROCK DRILLING METHODS		Approved D. Senovich	

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FIGURE

1.0 PURPOSE

The purpose of this procedure is to describe the methods and equipment necessary to perform soil and rock borings and identify the equipment, sequence of events, and appropriate methods necessary to obtain soil, both surface and subsurface, and rock samples during field sampling activities.

2.0 SCOPE

This guideline addresses most of the accepted and standard drilling techniques, their benefits, and drawbacks. It should be used generally to determine what type of drilling techniques would be most successful depending on site-specific geologic conditions and the type of sampling required.

The sampling methods described within this procedure are applicable to collecting surface and subsurface soil samples, and obtaining rock core samples for lithologic and hydrogeologic evaluation, excavation/foundation design and related civil engineering purposes.

3.0 GLOSSARY

Rock Coring - A method in which a continuous solid cylindrical sample of rock or compact rock-like soil is obtained by the use of a double tube core barrel that is equipped with an appropriate diamond-studded drill bit which is advanced with a hydraulic rotary drilling machine.

Wire-Line Coring - As an alternative to conventional coring, this technique is valuable in deep hole drilling, since this method eliminates trips in and out of the hole with the coring equipment. With this technique, the core barrel becomes an integral part of the drill rod string. The drill rod serves as both a coring device and casing.

4.0 RESPONSIBILITIES

Project Manager - In consultation with the project geologist, the Project Manager is responsible for evaluating the drilling requirements for the site and specifying drilling techniques that will be successful given the study objectives and geologic conditions at the site. The Project Manager also deterrnines the disposal methods for products generated by drilling, such as drill cuttings and well development water, as well as any specialized supplies or logistical support required for the drilling operations.

Field Operations Leader (FOL) - The FOL is responsible for the overall supervision and scheduling of drilling activities, and is strongly supported by the project geologist.

Project Geologist - The project geologist is responsible for ensuring that standard and approved drilling procedures are followed. The geologist will generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, and other pertinent drilling and testing information that may be obtained during drilling (see SOPs SA-6.3 and GH-1.5). Often this position for inspecting the drilling operations may be filled by other geotechnical personnel, such as soils and foundation engineers, civil engineers, etc.

Determination of the exact location for borings is the responsibility of the site geologist. The final location for drilling must be properly documented on the boring log. The general area in which the borings are to be located will be shown on a site map included in the Work Plan and/or Sampling and Analysis Plan.

Drilling Subcontractor - Operates under the supervision of the FOL. Responsible for obtaining all drilling permits and clearances, and supplying all services (including labor), equipment and material required to perform the drilling, testing, and well installation program, as well as maintenance and quality control of such required equipment except as stated in signed and approved subcontracts.

The driller must report any major technical or analytical problems encountered in the field to the FOL within 24 hours of determination, and must provide advance written notification of any changes in field procedures, describing and justifying such changes. No such changes shall be made unless requested and authorized in writing by the FOL (with the concurrence of the Project Manager).

The drilling subcontractor is responsible for following decontamination procedures specified in the project plan documents. Upon completion of the work, the driller is responsible for demobilizing all equipment, cleaning up any materials deposited on site during drilling operations, and properly backfilling any open borings.

5.0 PROCEDURES

5.1 General

The purpose of drilling boreholes is:

- To determine the type, thickness, and certain physical and chemical properties of the soil, water and rock strata which underlie the site.
- To install monitoring wells or piezometers.

All drilling and sampling equipment will be cleaned between samples and borings using appropriate decontamination procedures as outlined in SOP SA-7.1. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first, and at the most contaminated locations last, to reduce the risk of spreading contamination between locations. All borings must be logged by the rig geologist as they proceed (see SOPs SA-6.3 and GH-1.5). Situations where logging would not be required would include installation of multiple well points within a small area, or a "second attempt" boring adjacent to a boring that could not be continued through resistant material. In the latter case, the boring log can be resumed 5 feet above the depth at which the initial boring was abandoned, although the rig geologist should still confirm that the stratigraphy at the redrilled location conforms essentially with that encountered at the original location. If significant differences are seen, each hole should be logged separately.

5.2 Drilling Methods

The selected drilling methods described below apply to drilling in subsurface materials, including, but not limited to, sand, gravel, clay, silt, cobbles, boulders, rock and man-made fill. Drilling methods should be selected after studying the site geology and terrain, the waste conditions at the site, and reviewing the purpose of drilling and the overall subsurface investigation program proposed for the site. The full range of different drilling methods applicable to the proposed program should be identified with final selection based on relative cost, availability, time constraints, and how well each method meets the sampling and testing requirements of the individual drilling program.

5.2.1 Continuous-Flight Hollow-Stem Auger Drilling

This method of drilling consists of rotating augers with a hollow stem into the ground. Cuttings are brought to the surface by the rotating action of the auger. This method is relatively quick and inexpensive. Advantages of this type of drilling include:

- Samples can be obtained without pulling the augers out of the hole. However, this is a poor method for obtaining grab samples from thin, discrete formations because of mixing of soils which occurs as the material is brought to the surface. Sampling of such formations requires the use of split-barrel or thin-wall tube samplers advanced through the hollow core of the auger.

- No drilling fluids are required.

- A well can be installed inside the auger stem and backfilled as the augers are withdrawn.

Disadvantages and limitations of this method of drilling include:

- Augering can only be done in unconsolidated materials.

- The inside diameter of hollow stem augers used for well installation should be at least 4 inches greater than the well casing. Use of such large-diameter hollow-stem augers is more expensive than the use of small-diameter augers in boreholes not used for well installation. Furthermore, the density of unconsolidated materials and depths become more of a limiting factor. More friction is produced with the larger diameter auger and subsequently greater torque is needed to advance the boring.

- The maximum effective depth for drilling is 150 feet or less, depending on site conditions and the size of augers used.

- In augering through clean sand formations below the water table, the sand will tend to flow into the hollow stem when the plug is removed for soil sampling or well installation. If the condition of "running" or "flowing" sands is persistent at a site, an alternative method of drilling is recommended, in particular for wells or boreholes deeper than 25 feet.

- Hollow-stem auger drilling is the preferred method of drilling. Most alternative methods require the introduction of water or mud downhole (air rotary is the exception) to maintain the open borehole. With these other methods, great care must be taken to ensure that the method does not interfere with the collection of a representative sample (which is the objective of the borehole construction. With this in mind, the preferred order of choice of drilling method after hollow-stem augering (HSA) is:

    - Cable tool
    - Casing drive (air)
    - Air rotary
    - Mud rotary
    - Rotosonic
    - Drive and wash
    - Jetting

However, the use of any method will also depend on efficiency and cost-effectiveness. In many cases, mud rotary is the only feasible alternative to hollow-stem augering. Thus, mud rotary drilling is generally acceptable as a first substitute for HSA.

The procedures for sampling soils through holes drilled by hollow-stem auger shall conform with the applicable ASTM Standards: D1587-83 and D1586-84. The guidelines established in SOP SA-1.3 shall also be followed. The hollow-stem auger may be advanced by any power-operated drilling machine having sufficient torque and ram range to rotate and force the auger to the desired depth. The machine must, however, be equipped with the accessory equipment needed to perform required sampling, or rock coring.

The hollow-stem auger may be used without the plug when boring for geotechnical examination or for well installation. However, when drilling below the water table, specially designed plugs which allow passage of formation water but not solid material shall be used (see Reference 1 of this guideline). This drilling configuration method also prevents blow back and plugging of the auger when the plug is removed for sampling.

Alternately, it may be necessary to keep the hollow stem full of water, at least to the level of the water table, to prevent blowback and plugging of the auger. If water is added to the hole, it must be sampled and analyzed to determine if it is free from contaminants prior to use. In addition, the amount of water introduced, the amount recovered upon attainment of depth, and the amount of water extracted during well development must be carefully logged in order to ensure that a representative sample of the formation water can be obtained. Well development should occur as soon after well completion as practicable (see SOP GH-2.8 for well development procedures). If gravelly or hard material is encountered which prevents advancing the auger to the desired depth, augering should be halted and either driven casing or hydraulic rotary methods should be attempted. If the depth to the bedrock/soil interface and bedrock lithology must be determined, then a 5-foot confirmatory core run should be conducted (see Section 5.2.9).

At the option of the Field Operations Leader (in communication with the Project Manager), when resistant materials prevent the advancement of the auger, a new boring can be attempted. The original boring must be properly backfilled and the new boring started a short distance away at a location determined by the site geologist. If multiple water bearing strata were encountered, the original boring must be grouted. In some formations, it may be prudent to also grout borings which penetrate only the water table aquifer, since loose soil backfill in the boring may still provide a preferred pathway for surface liquids to reach the water table.

5.2.2 Continuous-Flight Solid-Stem Auger Drilling

This drilling method is similar to hollow-stem augering. Practical application of this method is severely restricted compared to use of hollow-stem augers. Split-barrel (split-spoon) sampling cannot be performed without pulling the augers out, which may allow the hole to collapse. The continuous-flight solid-stem auger drilling method is therefore very time consuming and is not cost effective. Also, augers would have to be withdrawn before installing a monitoring well, which again, may allow the hole to collapse. Furthermore, geologic logging by examining the soils brought to the surface is unreliable, and depth to water may be difficult to determine while drilling.

There would be very few situations where use of a solid-stem auger would be preferable to other drilling methods. The only practical applications of this method would be to drill boreholes for well installation where no lithologic information is desired and the soils are such that the borehole can be expected to remain open after the augers are withdrawn. Alternatively, this technique can be used to find depth to bedrock in an area when no other information is required from drilling.

5.2.3 Rotary Drilling

Direct rotary drilling includes air-rotary and fluid-rotary drilling. For air or fluid-rotary drilling, the rotary drill may be advanced to the desired depth by any power-operated drilling machine having sufficient torque and ram range to rotate and force the bit to the desired depth. The drilling machine must, however, be equipped with any accessory equipment needed to perform required sampling, or coring. Prior to sampling, any settled drill cuttings in the borehole must be removed.

Air-rotary drilling is a method of drilling where the drill rig simultaneously turns and exerts a downward pressure on the drilling rods and bit while circulating compressed air down the inside of the drill rods, around the bit, and out the annulus of the borehole. Air circulation serves to both cool the bit and remove the cuttings from the borehole. Advantages of this method include:

- The drilling rate is high (even in rock).
- The cost per foot of drilling is relatively low.
- Air-rotary rigs are common in most areas.
- No drilling fluid is required (except when water is injected to keep down dust).
- The borehole diameter is large, to allow room for proper well installation procedures.

Disadvantages to using this method include:

- Formations must be logged from the cuttings that are blown to the surface and thus the depths of materials logged are approximate.

- Air blown into the formation during drilling may "bind" the formation and impede well development and natural groundwater flow.

- In-situ samples cannot be taken, unless the hole is cased.

- Casing must generally be used in unconsolidated materials.

- Air-rotary drill rigs are large and heavy.

A variation of the typical air-rotary drill bit is a down hole hammer which hammers the drill bit down as it drills. This makes drilling in hard rock faster. Air-rotary drills can also be adapted to use for rock coring although they are generally slower than other types of core drills. A major application of the air-rotary drilling method would be to drill holes in rock for well installation.

Fluid-Rotary drilling operates in a similar manner to air-rotary drilling except that a drilling fluid ("mud") or clean water is used in place of air to cool the drill bit and remove cuttings. There are a variety of fluids that can be used with this drilling method, including bentonite slurry and synthetic slurries. If a drilling fluid other than water/cuttings is used, it must be a natural clay (i.e., bentonite) and a "background" sample of the fluid should be taken for analysis of possible organic or inorganic contaminants.

Advantages to the fluid-rotary drilling method include:

- The ability to drill in many types of formations.
- Relatively quick and inexpensive.
- Split-barrel (split-spoon) or thin-wall (Shelby) tube samples can be obtained without removing drill rods if the appropriate size drill rods and bits (i.e., fish-tail or drag bit) are used.
- In some borings temporary casing may not be needed as the drilling fluids may keep the borehole open.
- Drill rigs are readily available in most areas.

Disadvantages to this method include:

- Formation logging is not as accurate as with hollow-stem auger method if split-barrel (split-spoon) samples are not taken (i.e., the depths of materials logged from cuttings delivered to the surface are approximate).
- Drilling fluids reduce permeability of the formation adjacent to the boring to some degree, and require more extensive well development than "dry" techniques (augering, air-rotary).
- No information on depth to water is obtainable while drilling.
- Fluids are needed for drilling, and there is some question about the effects of the drilling fluids on subsequent water samples obtained. For this reason as well, extensive well development may be required.
- In very porous materials (i.e., rubble fill, boulders, coarse gravel) drilling fluids may be continuously lost into the formation. This requires either constant replenishment of the drilling fluid, or the use of casing through this formation.
- Drill rigs are large and heavy, and must be supported with supplied water.
- Groundwater samples can be potentially diluted with drilling fluid.

The procedures for performing direct rotary soil investigations and sampling shall conform with the applicable ASTM standards: D2113-83, D1587-83, and D1586-84.

Soil samples shall be taken as specified by project plan documents, or more frequently, if requested by the project geologist. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool.

When field conditions prevent the advancement of the hole to the desired depth, a new boring may be drilled at the request of the Field Operations Leader. The original boring shall be backfilled using methods and materials appropriate for the given site and a new boring started a short distance away at a location determined by the project geologist.

5.2.4 Rotosonic Drilling

The Rotosonic drilling method employs a high frequency vibrational and low speed rotational motion coupled with down pressure to advance the cutting edge of a drill string. This produces a uniform borehole while providing a continuous, undisturbed core sample of both unconsolidated and most bedrock formations. Rotosonic drilling advances a 4-inch diameter to 12-inch diameter core barrel for sampling and can advance up to a 12-inch diameter outer casing for the construcito of standard and telescoped monitoring wells. During drilling, the core barrel is advanced ahead of the outer barrel in increments as determined by the site geologist and depending upon type of material, degree of subsurface contamination and sampling objectives.

The outer casing can be advanced at the same time as the inner drill string and core barrel, or advanced down over the inner drill rods and core barrel, or after the core barrel has moved ahead to collect the undisturbed sample and has been pulled out of the borehole. The outer casing can be advanced dry in most cases, or can be advanced with water or air depending upon the formations being drilled, the depth and diameter of the hole, or requirements of the project.

Advantages of this method include:

- Sampling and well installation are faster as compared to other drilling methods.
- Continuous sampling, with larger sample volume as compared to split-spoon sampling.
- The ability to drill through difficult formations such as cobbles or boulders, hard till and bedrock.
- Reduction of IDW by an average of 70 to 80 percent.
- Well installations are quick and controlled by elimination of potential bridging of annular materials during well installation, due to the ability to vibrate the outer casing during removal.

Disadvantages include:

- The cost for Rotosonic drilling as compared to other methods are generally higher. However, the net result can be a significant savings considering reduced IDW and shortened project duration.
- Rotosonic drill rigs are large and need ample room to drill, however, Rotosonic units can be placed on the ground or placed on an ATV.
- There are a limited number of Rotosonic drilling contractors at the present time.

5.2.5 Reverse Circulation Rotary Drilling

The common reverse-circulation rig is a water or mud-rotary rig with a large-diameter drill pipe which circulates the drilling water down the annulus and up the inside of the drill pipe (reverse flow direction from direct mud-rotary). This type of rig is used for the construction of large-capacity production water wells and is not suited for small, water quality sampling wells because of the use of drilling muds and the large-diameter hole which is created. A few special reverse-circulation rotary rigs are made with double-wall drill pipe. The drilling water or air is circulated down the annulus between the drill pipes and up inside the inner pipe.

Advantages of the latter method include:

- The formation water is not contaminated by the drilling water.
- Formation samples can be obtained, from known depths.
- When drilling with air, immediate information is available regarding the water-bearing properties of formations penetrated.
- Collapsing of the hole in unconsolidated formations is not as great a problem as when drilling with the normal air-rotary rig.

Disadvantages include:

- Double-wall, reverse-circulation drill rigs are very rare and expensive to operate.
- Placing cement grout around the outside of the well casing above a well screen often is difficult, especially when the screen and casing are placed down through the inner drill pipe before the drill pipe is pulled out.

5.2.6 Drill-through Casing Driver

The driven-casing method consists of alternately driving casing (fitted with a sharp, hardened casing shoe) into the ground using a hammer lifted and dropped by the drill rig (or an air-hammer) and cleaning out the casing using a rotary chopping bit and air or water to flush out the materials. The casing is driven down in stages (usually 5 feet per stage); a continuous record is kept of the blows per foot in driving the casing (see SOP GH-1.5). The casing is normally advanced by a 300-pound hammer falling freely through a height of 30 inches. Simultaneous washing and driving of the casing is not recommended. If this procedure is used, the elevations within which wash water is used and in which the casing is driven must be clearly recorded.

The driven casing method is used in unconsolidated formations only. When the boring is to be used for later well installation, the driven casing used should be at least 4 inches larger in diameter than the well casing to be installed. Advantages to this method of drilling include:

- Split-barrel (split-spoon) sampling can be conducted while drilling.
- Well installation is easily accomplished.
- Drill rigs used are relatively small and mobile.
- The use of casing minimizes flow into the hole from upper water-bearing layers; therefore, multiple aquifers can be penetrated and sampled for rough field determinations of some water quality parameters.

Some of the disadvantages include:

- This method can only be used in unconsolidated formations.
- The method is slower than other methods (average drilling progress is 30 to 50 feet per day).

- Maximum depth of the borehole varies with the size of the drill rig and casing diameter used, and the nature of the formations drilled.

- The cost per hour or per foot of drilling may be substantially higher than other drilling methods.

- It is difficult and time consuming to pull back the casing if it has been driven very deep (deeper than 50 feet in many formations).

5.2.7 Cable Tool Drilling

A cable tool rig uses a heavy, solid-steel, chisel-type drill bit ("tool") suspended on a steel cable, which when raised and dropped, chisels or pounds a hole through the soils and rock. Drilling progress may be expedited by the use of "slip-jars" which serve as a cable-activated down hole percussion device to hammer the bit ahead.

When drilling through the unsaturated zone, some water must be added to the hole. The cuttings are suspended in the water and then bailed out periodically. Below the water table, after sufficient ground water enters the borehole to replace the water removed by bailing, no further water needs to be added.

When soft caving formations are encountered, it is usually necessary to drive casing as the hole is advanced to prevent collapse of the hole. Often the drilling can be only a few feet below the bottom of the casing. Because the drill bit is lowered through the casing, the hole created by the bit is smaller than the casing. Therefore, the casing (with a sharp, hardened casing shoe on the bottom) must be driven into the hole (see Section 5.2.5 of this guideline).

Advantages of the cable-tool method include the following:

- Information regarding water-bearing zones is readily available during the drilling. Even relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators.

- The cable-tool rig can operate satisfactorily in all formations, but is best suited for caving, boulder, cable or coarse gravel type formations (e.g., glacial till) or formations with large cavities above the water table (such as limestones).

- When casing is used, the casing seals formation water out of the hole, preventing down hole contamination and allowing sampling of deeper aquifers for field-measurable water quality parameters.

- Split-barrel (split-spoon) or thin-wall (Shelby) tube samples can be collected through the casing.

Disadvantages include:

- Drilling is slow compared with rotary rigs.

- The necessity of driving the casing in unconsolidated formations requires that the casing be pulled back if exposure of selected water-bearing zones is desired. This process complicates the well completion process and often increases costs. There is also a chance that the casing may become stuck in the hole.

- The relatively large diameters required (minimum of 4-inch casing) plus the cost of steel casing result in higher costs compared to rotary drilling methods where casing is not required (e.g., such use of a hollow-stem auger).

- Cable-tool rigs have largely been replaced by rotary rigs. In some parts of the U.S., availability may be difficult.

5.2.8 Jet Drilling (Washing)

Jet drilling, which should be used only for piezometer or vadose zone sampler installation, consists of pumping water or drilling mud down through a small diameter (1/2- to 2-inch) standard pipe (steel or PVC). The pipe may be fitted with a chisel bit or a special jetting screen. Formation materials dislodged by the bit and jetting action of the water are brought to the surface through the annulus around the pipe. As the pipe is jetted deeper, additional lengths of pipe may be added at the surface.

Jet percussion is a variation of the jetting method, in which the casing is driven with a drive weight. Normally, this method is used to place 2-inch-diameter casing in shallow, unconsolidated sand formations, but this method has also been used to install 3- to 4-inch-diameter casings to a depth of 200 feet.

Jetting is acceptable in very soft formations, usually for shallow sampling, and when introduction of drilling water to the formation is acceptable. Such conditions would occur during rough stratigraphic investigation or installation of piezometers for water level measurement. Advantages of this method include:

- Jetting is fast and inexpensive.

- Because of the small amount of equipment required, jetting can be accomplished in locations where access by a normal drilling rig would be very difficult. For example, it would be possible to jet down a well point in the center of a lagoon at a fraction of the cost of using a drill rig.

- Jetting numerous well points just into a shallow water table is an inexpensive method for determining the water table contours, hence flow direction.

Disadvantages include the following:

- A large amount of foreign water or drilling mud is introduced above and into the formation to be sampled.

- Jetting is usually done in very soft formations which are subject to caving. Because of this caving, it is often not possible to place a grout seal above the screen to assure that water in the well is only from the screened interval.

- The diameter of the casing is usually limited to 2 inches; therefore, samples must be obtained by methods applicable to small diameter casings.

- Jetting is only possible in very soft formations that do not contain boulders or coarse gravel, and the depth limitation is shallow (about 30 feet without jet percussion equipment).

- Large quantities of water are often needed.

5.2.9 Drilling with a Hand Auger

This method is applicable wherever the formation, total depth of sampling, and the site and groundwater conditions are such as to allow hand auger drilling. Hand augering can also be considered at locations where drill rig access is not possible. All hand auger borings will be performed according to ASTM D1452-80.

Samples should be taken continuously unless otherwise specified by the project plan documents. Any required sampling is performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. Typical equipment used for sampling and advancing shallow "hand auger" holes are Iwan samplers (which are rotated) or post hole diggers (which are operated like tongs). These techniques are slow but effective where larger pieces of equipment do not have access, and where very shallow holes are desired (less than 15 feet). Surficial soils must be composed of relatively soft and non-cemented formations to allow penetration by the auger.

5.2.10 Rock Drilling and Coring

When soil borings cannot be continued using augers or rotary methods due to the hardness of the soil or when rock or large boulders are encountered, drilling and sampling can be performed using a diamond bit corer in accordance with ASTM D2113.

Drilling is done by rotating and applying downward pressure to the drill rods and drill bit. The drill bit is a circular, hollow, diamond-studded bit attached to the outer core barrel in a double-tube core barrel. The use of single-tube core barrels is not recommended, as the rotation of the barrel erodes the sample and limits its use for detailed geological evaluation. Water or air is circulated down through the drill rods and annular space between the core barrel tubes to cool the bit and remove the cuttings. The bit cuts a core out of the rock which rises into an inner barrel mounted inside the outer barrel. The inner core barrel and rock core are removed by lowering a wire line with a coupling into the drill rods, latching onto the inner barrel and withdrawing the inner barrel. A less efficient variation of this method utilizes a core barrel that cannot be removed without pulling all of the drill rods. This variation is practical only if less than 50 feet of core is required.

Core borings are made through the casing used for the soil borings. The casing must be driven and sealed into the rock formation to prevent seepage from the overburden into the hole to be cored (see Section 5.3 of this guideline). A double-tube core barrel with a diamond bit and reaming shell or equivalent should be used to recover rock cores of a size specified in the project plans. The most common core barrel diameters are listed in Attachment A.

Soft or decomposed rock should be sampled with a driven split-barrel whenever possible or cored with a Denison or Pitcher sampler.

When coring rock, including shale and claystone, the speed of the drill and the drilling pressure, amount and pressure of water, and length of run can be varied to give the maximum recovery from the rock being drilled. Should any rock formation be so soft or broken that the pieces continually fall into the hole causing unsatisfactory coring, the hole should be reamed and a flush-joint casing installed to a point below the broken formation. The size of the flush-joint casing must permit securing the core size specified. When soft or broken rock is anticipated, the length of core runs should be reduced to less than 5 feet to avoid core loss and minimize core disturbance.

Advantages of core drilling include:

- Undisturbed rock cores can be recovered for examination and/or testing.
- In formations in which the cored hole will remain open without casing, water from the rock fractures may be recovered from the well without the installation of a well screen and gravel pack.
- Formation logging is extremely accurate.
- Drill rigs are relatively small and mobile.

Disadvantages include:

- Water or air is needed for drilling.
- Coring is slower than rotary drilling (and more expensive).
- Depth to water cannot accurately be determined if water is used for drilling.
- The size of the borehole is limited.

This drilling method is useful if accurate determinations of rock lithology are desired or if open wells are to be installed into bedrock. To install larger diameter wells in coreholes, the hole must be reamed out to the proper size after boring, using air or mud rotary drilling methods.

5.2.11 Drilling & Support Vehicles

In addition to the drilling method required to accomplish the objectives of the field program, the type of vehicle carrying the drill rig and/or support equipment and its suitability for the site terrain, will often be an additional deciding factor in planning the drilling program. The types of vehicles available are extensive, and depend upon the particular drilling subcontractor's fleet. Most large drilling subcontractors will have a wide variety of vehicle and drill types suited for most drilling assignments in their particular region, while smaller drilling subcontractors will usually have a fleet of much more limited diversity. The weight, size, and means of locomotion (tires, tracks, etc.) of the drill rig must be selected to be compatible with the site terrain to assure adequate mobility between borehole locations. Such considerations also apply to necessary support vehicles used to transport water and/or drilling materials to the drill rigs at the borehole locations. When the drill rigs or support vehicles do not have adequate mobility to easily traverse the site, provisions must be made for assisting equipment, such as bulldozers, winches, timber planking, etc., to maintain adequate progress during the drilling program.

Some of the typical vehicles which are usually available for drill rigs and support equipment are:

- Totally portable drilling/sampling equipment, where all necessary components (tripods, samplers, hammers, catheads, etc.) may be hand carried to the borehole site. Drilling/sampling methods used with such equipment include:
  - Hand augers and lightweight motorized augers.
  - Retractable plug samplers--driven by hand (hammer).

- Motorized cathead - a lightweight aluminum tripod with a small gas-engine cathead mounted on one leg, used to install small-diameter cased borings. This rig is sometimes called a "monkey on a stick."

- Skid-mounted drilling equipment containing a rotary drill or engine-driven cathead (to lift hammers and drill string), a pump, and a dismounted tripod. The skid is pushed, dragged, or winched (using the cathead drum) between boring locations.

- Small truck-mounted drilling equipment using a jeep, stake body or other light truck (4 to 6 wheels), upon which are mounted the drill and/or a cathead, a pump, and a tripod or small drilling derrick. On some rigs, the drill and/or a cathead are driven by a power take-off from the truck, instead of by a separate engine.

- Track-mounted drilling equipment is similar to truck-mounted rigs, except that the vehicle used has wide bulldozer tracks for traversing soft ground. Sometimes a continuous-track "all terrain vehicle" is also modified for this purpose. Some types of tracked drill rigs are called "bombardier" or "weasel" rigs.

- Heavy truck-mounted drilling equipment is mounted on tandem or dual tandem trucks to transport the drill, derrick, winches, and pumps or compressors. The drill may be provided with a separate engine or may use a power take-off from the truck engine. Large augers, hydraulic rotary and reverse circulation rotary drilling equipment are usually mounted on such heavy duty trucks. For soft-ground sites, the drilling equipment is sometimes mounted on and off the road vehicle having low pressure, very wide diameter tires and capable of floating; these vehicles are called "swamp buggy" rigs.

- Marine drilling equipment is mounted on various floating equipment for drilling borings in lakes, estuaries and other bodies of water. The floating equipment varies, and is often manufactured or customized by the drilling subcontractor to suit specific drilling requirements. Typically, the range of flotation vehicles include:

  - Barrel-float rigs - a drill rig mounted on a timber platform buoyed by empty 55-gallon drums or similar flotation units.

  - Barge-mounted drill rigs.

  - Jack-up platforms - drilling equipment mounted on a floating platform having retractable legs to support the unit on the sea or lake bed when the platform is jacked up out of the water.

  - Drill ships - for deep ocean drilling.

In addition to the mobility for the drilling equipment, similar consideration must be given for equipment to support the drilling operations. Such vehicles or floating equipment are needed to transport drill water, drilling supplies and equipment, samples, drilling personnel, etc. to and/or from various boring locations.

5.2.12 Equipment Sizes

In planning subsurface exploration programs, care must be taken in specifying the various drilling components, so that they will fit properly in the boring or well.

For drilling open boreholes using rotary drilling equipment, tri-cone drill bits are employed with air, water or drilling mud to remove cuttings and cool the bit. Tri-cone bits are slightly smaller than the holes they drill (i.e., 5-7/8-inch or 7-7/8-inch bits will nominally drill 6-inch and 8-inch holes, respectively).

For obtaining split-barrel samples of a formation, samplers are commonly manufactured in sizes ranging from 2 inches to 3-1/2 inches in outside diameter. However, the most commonly used size is the 2-inch O.D., 1-3/8-inch I.D. split-barrel sampler. When this sampler is used and driven by a 140-pound (± 2-pound) hammer dropping 30 inches (± 1 inch), the procedure is called a Standard Penetration Test, and the blows per foot required to advance the sampler into the formation can be correlated to the formation's density or strength.

In planning the drilling of boreholes using hollow-stem augers or casing, in which thin-wall tube samples or diamond core drilling will be performed, refer to the various sizes and clearances provided in Attachment A of this guideline. Sizes selected must be stated in the project plan documents.

5.2.13 Estimated Drilling Progress

To estimate the anticipated rates of drilling progress for a site, the following must be considered:

- The speed of the drilling method employed.
- Applicable site conditions (e.g., terrain, mobility between borings, difficult drilling conditions in bouldery soils, rubble fill or broken rock, etc.).
- Project-imposed restrictions (e.g., drilling while wearing personal protective equipment, decontamination of drilling equipment, etc.).

Based on recent experience in drilling average soil conditions (no boulders) and taking samples at 5-foot intervals, for moderate depth (30 feet to 50 feet) boreholes (not including installation or development of wells), the following daily rates of total drilling progress may be anticipated for the following drilling methods:

Drilling Method	Average Daily Progress (linear feet)
Hollow-stem augers	75'
Solid-stem augers	50'
Mud-Rotary Drilling	100' (cuttings samples)
Rotosonic Drilling	100'-160' (continuous core)
Reverse-Circulation Rotary	100' (cuttings samples)
Skid-Rig with driven casing	30'
Rotary with driven casing	50'
Cable Tool	30'
Hand Auger	Varies
Continuous Rock Coring	50'

5.3 Prevention of Cross-Contamination

A telescoping or multiple casing technique minimizes the potential for the migration of contaminated groundwater to lower strata below a confining layer. The telescoping technique consists of drilling to a confining layer utilizing a spun casing method with a diamond cutting or augering shoe (a method similar to the rock coring method described in Section 5.2.10, except that larger casing is used) or by using a driven-casing method (see Section 5.2.6 of this guideline) and installing a specified diameter steel well casing. The operation consists of three separate steps. Initially, a drilling casing (usually of 8-inch diameter) is installed followed by installation of the well casing (6-inch-diameter is common for 2-inch wells). This well casing is driven into the confining layer to ensure a tight seal at the bottom of the hole. The well casing is sealed at the bottom with a bentonite-cement slurry. The remaining depth of the boring is drilled utilizing a narrower diameter spun or driven casing technique within the outer well casing. A smaller diameter well casing with an appropriate length of slotted screen on the lower end, is installed to the surface.

Clean sand is placed in the annulus around and to a point of about 2 feet above the screen prior to withdrawal of the drilling casing. The annular space above the screen and to a point 2 feet above the bottom of the outer well casing is sealed with a tremied cement-bentonite slurry which is pressure-grouted or displacement-grouted into the hole. The remaining casing annulus is backfilled with clean material and grouted at the surface, or it is grouted all the way to the surface.

5.4 Cleanout of Casing Prior to Sampling

The boring hole must be completely cleaned of disturbed soil, segregated coarse material and clay adhering to the inside walls of the casing. The cleaning must extend to the bottom edge of the casing and, if possible, a short distance further (1 or 2 inches) to bypass disturbed soil resulting from the advancement of the casing. Loss of wash water during cleaning should be recorded.

For disturbed samples both above and below the water table and where introduction of relatively large volumes of wash water is permissible, the cleaning operation is usually performed by washing the material out of the casing with water; however, the cleaning should never be accomplished with a strong, downward-directed jet which will disturb the underlying soil. When clean out has reached the bottom of the casing or slightly below (as specified above), the string of tools should be lifted one foot off the bottom with the water still flowing, until the wash water coming out of the casing is clear of granular soil particles. In formations where the cuttings contain gravel and other larger particles, it is often useful to repeatedly raise and lower the drill rods and wash bit while washing out the hole, to surge these large particles upward out of the hole. As a time saver, the drilling contractor may be permitted to use a split-barrel (split-spoon) sampler with the ball check valve removed as the clean-out tool, provided the material below the spoon is not disturbed and the shoe of the spoon is not damaged. However, because the ball check valve has been removed, in some formations it may be necessary to install a flap valve or spring sample retainer in the split-spoon bit, to prevent the sample from falling out as the sampler is withdrawn from the hole. The use of jet-type chopping bits is discouraged except where large boulders and cobbles or hard-cemented soils are encountered. If water markedly softens the soils above the water table, clean out should be performed dry with an auger.

For undisturbed samples below the water table, or where wash water must be minimized, clean out is usually accomplished with an appropriate diameter clean out auger. This auger has cutting blades at the bottom to carry loose material up into the auger, and up-turned water jets just above the cutting blades to carry the removed soil to the surface. In this manner, there is a minimum of disturbance at the top of the material to be sampled. If any gravel material washes down into the casing and cannot be removed by the clean out auger, a split-barrel sample can be taken to remove it; bailers and sandpumps should not be used. For undisturbed samples above the groundwater table, all operations must be performed in a dry manner.

If all of the cuttings created by drilling through the overlying formations are not cleaned from the borehole prior to sampling, some of the problems which may be encountered during sampling include:

- When sampling is attempted through the cuttings remaining in the borehole, all or part of the sampler may become filled with the cuttings. This limits the amount of sample from the underlying formation which can enter and be retained in the sampler, and also raises questions as to the validity of the sample.

- If the cuttings remaining in the borehole contain coarse gravel and/or other large particles, these may block the bit of the sampler and prevent any materials from the underlying formation from entering the sampler when the sampler is advanced.

- In cased borings, should sampling be attempted through cuttings which remain in the lower portion of the casing, these cuttings could cause the sampler to become bound into the casing, such that it becomes very difficult to either advance or retract the sampler.

- When sampler blow counts are used to estimate the density or strength of the formation being sampled, the presence of cuttings in the borehole will usually give erroneously high sample blow counts.

To confirm that all cuttings have been removed from the borehole prior to attempting sampling, it is important that the rig geologist measure the "stickup" of the drill string. This is accomplished by measuring the assembled length of all drill rods and bits or samplers (the drill string) as they are lowered to the bottom of the hole, below some convenient reference point of the drill string, then measuring the height of this reference point above the ground surface. The difference of these measurements is the depth of the drill string (lower end of the bit or sampler) below the ground surface, which must then be compared with the depth of sampling required (installed depth of casing or depth of borehole drilled). If the length of drill string below grade is more than the drilled or casing depth, the borehole has been cleaned too deeply, and this deeper depth of sampling must be recorded on the log. If the length of drill string below grade is less than the drilled or casing depth, the difference represents the thickness of cuttings which remain in the borehole. In most cases, an inch or two of cuttings may be left in the borehole with little or no problem. However, if more than a few inches of cuttings are encountered, the borehole must be recleaned prior to attempting sampling.

5.5 Materials of Construction

The effects of monitoring well construction materials on specific chemical analytical parameters are described and/or referenced in SOP GH-2.8. However, there are several materials used during drilling, particularly drilling fluids and lubricants, which must be used with care to avoid compromising the representativeness of soil and ground water samples.

The use of synthetic or organic polymer slurries is not permitted at any location where soil samples for chemical analysis are to be collected. These slurry materials could be used for installation of long-term monitoring wells, but the early time data in time series collection of ground water data may then be suspect. If synthetic or organic polymer muds are proposed for use at a given site, a complete written justification including methods and procedures for their use must be provided by the site geologist and approved by the Project Manager. The specific slurry composition and the concentration of suspected contaminants for each site must be known.

For many drilling operations, potable water is an adequate lubricant for drill stem and drilling tool connections. However, there are instances, such as drilling in tight clayey formations or in loose gravels, when threaded couplings must be lubricated to avoid binding. In these instances, to be determined in the field by the judgment of the site geologist and noted in the site logbook, and only after approval by the Project Manager, a vegetable oil or silicone-based lubricant should be used. Petroleum based greases, etc. will not be permitted. Samples of lubricants used must be provided and analyzed for chemical parameters appropriate to the given site.

5.6 Subsurface Soil Samples

Subsurface soil samples are used to characterize subsurface stratigraphy. This characterization can indicate the potential for migration of chemical contaminants in the subsurface. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Where the remedial activities may include in-situ treatment or excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Engineering and physical properties of soil may also be of interest should site construction activities be planned. Soil types, grain size distribution, shear strength, compressibility, permeability, plasticity, unit weight, and moisture content are some of the physical characteristics that may be determined for soil samples.

Penetration tests are also described in this procedure. The tests can be used to estimate various physical and engineering parameters such as relative density, unconfined compressive strength, and consolidation characteristics of soils.

Surface protocols for various soil sampling techniques are discussed in SOP SA-1.3. Continuous-core soil sampling and rock coring are discussed below. The procedures described here are representative of a larger number of possible drilling and sampling techniques. The choice of techniques is based on a large number of variables such as cost, local geology, etc. The final choice of methods must be made with the assistance of drilling subcontractors familiar with the local geologic conditions. Alternative techniques must be based upon the underlying principles of quality assurance implicit in the following procedures.

The CME continuous sample tube system provides a method of sampling soil continuously during hollow-stem augering. The 5-foot sample barrel fits within the lead auger of a hollow-auger column. The sampling system can be used with a wide range of I.D. hollow-stem augers (from 3-1/4-inch to 8-1/4-inch I.D.). This method has been used to sample many different materials such as glacial drift, hard clays and shales, mine tailings, etc. This method is particularly used when SPT samples are not required and a large volume of material is needed. Also, this method is useful when a visual description of the subsurface lithology is required. Rotosonic drilling methods also provide a continuous soil sample.

5.7 Rock Sampling (Coring) (ASTM D2113-83)

Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less, or for specific intervals in the drill hole that require detailed logging and/or analyzing. Rock coring can, however, proceed for thousands of feet continuously, depending on the size of the drill rig, and yields better quality data than air-rotary drilling, although at a substantially reduced drilling rate. Rate of drilling varies widely, depending on the characteristics of lithologies encountered, drilling methods, depth of drilling, and condition of drilling equipment. Average output in a 10-hour day ranges from 40 to over 200 feet. Down hole geophysical logging or television camera monitoring is sometimes used to complement the data generated by coring.

Borehole diameter can be drilled to various sizes, depending on the information needed. Standard sizes of core barrels (showing core diameter) and casing are shown in Figure 1.

Core drilling is used when formations are too hard to be sampled by soil sampling methods and a continuous solid sample is desired. Usually, soil samples are used for overburden, and coring begins in sound bedrock. Casing is set into bedrock before coring begins to prevent loose material from entering the borehole, to prevent loss of drilling fluid, and to prevent cross-contamination of aquifers.

Drilling through bedrock is initiated by using a diamond-tipped core bit threaded to a drill rod (outer core barrel) with a rate of drilling determined by the downward pressure, rotation speed of drill rods, drilling fluid pressure in the borehole, and the characteristics of the rock (mineralogy, cementation, weathering).

5.7.1 Diamond Core Drilling

A penetration of typically less than 6 inches per 50 blows using a 140-lb. hammer dropping 30 inches with a 2-inch split-barrel sampler shall be considered an indication that soil sampling methods may not be applicable and that coring may be necessary to obtain samples.

When formations are encountered that are too hard to be sampled by soil sampling methods, the following diamond core drilling procedure may be used:

- Firmly seat a casing into the bedrock or the hard material to prevent loose materials from entering the hole and to prevent the loss of drilling fluid return. Level the surface of the rock or hard material when necessary by the use of a fishtail or other bits. If the drill hole can be retained open without the casing and if cross-contamination of aquifers in the unconsolidated materials is unlikely, leveling may be omitted.

- Begin the core drilling using a double-tube swivel-core barrel of the desired size. After drilling no more than 10 feet (3 m), remove the core barrel from the hole and take out the core. If the core blocks the flow of the drilling fluid during drilling, remove the core barrel immediately. In soft materials, a large starting size may be specified for the coring tools; where local experience indicates satisfactory core recovery or where hard, sound materials are anticipated, a smaller size or the single-tube type may be specified and longer runs may be drilled. NX/NW size coring equipment is the most commonly used size.

- When soft materials are encountered that produce less than 50 percent recovery, stop the core drilling. If soil samples are desired, secure such samples in accordance with the procedures described in ASTM Method D 1586 (Split-barrel Sampling) or in Method D 1587 (Thin-Walled Tube Sampling); sample soils per SOP SA-1.3. Resume diamond core drilling when refusal materials are again encountered.

- Since rock structures and the occurrence of seams, fissures, cavities, and broken areas are among the most important items to be detected and described, take special care to obtain and record these features. If such broken zones or cavities prevent further advance of the boring, one of the following three steps shall be taken: (1) cement the hole; (2) ream and case; or (3) case and advance with the next smaller size core barrel, as conditions warrant.

FIGURE 1

STANDARD SIZES OF CORE BARRELS AND CASING

Coring Bit Size	Nominal*		Set Size*	
	O.D.	I.D.	O.D.	I.D.
RWT	1 5/32	3/4	1.160	0.735
EWT	1 1/2	29/32	1.470	0.905
EX, EXL, EWG, EWM	1 1/2	13/16	1.470	0.845
AWT	1 7/8	1 9/32	1.875	1.281
AX, AXL, AWG, AWM	1 7/8	1 3/16	1.875	1.185
BWT	2 3/8	1 3/4	2.345	1.750
BX, BXL, BWG, BWM	2 3/8	1 5/8	2.345	1.655
NWT	3	2 5/16	2.965	2.313
NX, NXL, NWG, NWM	3	2 1/8	2.965	2.155
HWT	3 29/32	3 3/16	3.889	3.187
HWG	3 29/32	3	3.889	3.000
2 3/4 x 3 7/8	3 7/8	2 3/4	3.840	2.690
4 x 5 1/2	5 1/2	4	5.435	3.970
6 x 7 3/4	7 3/4	6	7.655	5.970
AX Wire line ___|___/	1 7/8	1	1.875	1.000
BX Wire line ___|___/	2 3/8	1 7/16	2.345	1.437
NX Wire line ___|___/	3	1 15/16	2.965	1.937

* All dimensions are in inches; to convert to millimeters, multiply by 254.

___|___/ Wire line dimensions and designations may vary according to manufacturer.

FIGURE 1
STANDARD SIZES OF CORE BARRELS AND CASING
PAGE TWO

Size Designations		Casing O.D., Inches	Casing Coupling		Casing bit O.D., Inches	Core barrel bit O.D., Inches*	Drill rod O.D., Inches	Approximate Core Diameter	
Casing; Casing coupling; Casing bits; Core barrel bits	Rod; rod couplings		O.D., Inches	I.D., Inches				Normal, Inches	Thinwall, Inches
RX	RW	1.437	1.437	1.188	1.485	1.160	1.094	---	0.735
EX	E	1.812	1.812	1.500	1.875	1.470	1.313	0.845	0.905
AX	A	2.250	2.250	1.906	2.345	1.875	1.625	1.185	1.281
BX	B	2.875	2.875	2.375	2.965	2.345	1.906	1.655	1.750
NX	N	3.500	3.500	3.000	3.615	2.965	2.375	2.155	2.313
HX	HW	4.500	4.500	3.938	4.625	3.890	3.500	3.000	3.187
RW	RW	1.437	Flush Joint	No Coupling	1.485	1.160	1.094	---	0.735
EW	EW	1.812			1.875	1.470	1.375	0.845	0.905
AW	AW	2.250			2.345	1.875	1.750	1.185	1.281
BW	BW	2.875			2.965	2.345	2.125	1.655	1.750
NW	NW	3.500			3.615	2.965	2.625	2.155	2.313
HW	HW	4.500			4.625	3.890	3.500	3.000	3.187
PW	---	5.500			5.650	---	---	---	---
SW	---	6.625			6.790	---	---	---	---
UW	---	7.625			7.800	---	---	---	---
ZW	---	8.625			8.810	---	---	---	---
---	AX __|__\	---	---	---	---	1.875	1.750	1.000	---
---	BX __|__\	---	---	---	---	2.345	2.250	1.437	---
---	NX __|__\	---	---	---	---	2.965	2.813	1.937	---

* All dimensions are in inches; to convert to millimeters, multiply by 254.

___|___/ Wire line dimensions and designations may vary according to manufacturer.

NOMINAL DIMENSIONS FOR DRILL CASINGS AND ACCESSORIES. (DIAMOND CORE DRILL MANUFACTURERS ASSOCIATION). 288-D-2889

- In soft, seamy, or otherwise unsound rock, where core recovery may be difficult, M-design core barrels may be used. In hard, sound rock where a high percentage of core recovery is anticipated, the single-tube core barrel may be employed.

5.7.2 Rock Sample Preparation and Documentation

Once the rock coring has been completed and the core recovered, the rock core shall be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core shall be described, classified, and logged using a uniform system as presented in SOP GH-1.5. If moisture content will be determined or if it is desirable to prevent drying (e.g., to prevent shrinkage of clay formations) or oxidation of the core, the core shall be wrapped in plastic sleeves immediately after logging. Each plastic sleeve shall be labeled with indelible ink. The boring number, run number, and the footage represented in each sleeve shall be included, as well as designating the top and bottom of the core run.

After sampling, rock cores shall be placed in the sequence of recovery in well-constructed wooden boxes provided by the drilling contractor. Rock cores from two different borings shall not be placed in the same core box unless accepted by the Project Geologist. The core boxes shall be constructed to accommodate at least 20 linear feet of core in rows of approximately 5 feet each and shall be constructed with hinged tops secured with screws, and a latch (usually a hook and eye) to keep the top securely fastened down. Wood partitions shall be placed at the end of each core run and between rows.

The depth from the surface of the boring to the top and bottom of the drill run and run number shall be marked on the wooden partitions with indelible ink. A wooden partition (wooden block) shall be placed at the end of each run with the depth of the bottom of the run written on the block. These blocks will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores shall be the same in all core boxes. Rock core shall be placed in the box so that, when the box is open, with the inside of the lid facing the observer, the top of the cored interval contained within the box is in the upper left corner of the box, and the bottom of the cored interval is in the lower right corner of the box. The top and bottom of each core obtained and its true depth shall be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row shall be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.
The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data on the box's contents. At a minimum, the following information shall be included:

- Project name.
- Project number.
- Boring number.
- Run numbers.
- Footage (depths).
- Recovery.
- RQD (%).
- Box number and total number of boxes for that boring (Example: Box 5 of 7).

For easy retrieval when core boxes are stacked, the sides and ends of the box shall also be labeled and include project number, boring number, top and bottom depths of core and box number.

Prior to final closing of the core box, a photograph of the recovered core and the labeling on the inside cover shall be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores).

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ATTACHMENT A

DRILLING EQUIPMENT SIZES

Drilling Component	Designation or Hole Size (Inches)	O.D. (Inches)	I.D. (Inches)	Coupling I.D. (Inches)
Hollow-stem augers (Ref. 7)	6 1/4	5	2 1/4	
	6 3/4	5 3/4	2 3/4	---
	7 1/4	6 1/4	3 1/4	---
	13 1/4	12	6	---
Thin Wall Tube Samplers (Ref. 7)	---	2	1 7/8	---
	---	2 1/2	2 3/8	---
	---	3	2 7/8	---
	---	3 1/2	3 3/8	---
	---	4 1/2	4 3/8	---
	---	5	4 3/4	---
Drill Rods (Ref. 7)	RW	1 3/32	23/32	13/32
	EW	1 3/8	15/16	7/16
	AW	1 3/4	1 1/4	5/8
	BW	2 1/8	1 3/4	3/4
	NW	2 5/8	2 1/4	1 3/8
	HW	3 1/2	3 1/16	2 3/8
	E	1 5/16	7/8	7/16
	A	1 5/8	1 1/8	9/16
	B	1 7/8	1 1/4	5/8
	N	2 3/8	2	1
				Wall Thickness (Inches)
Driven External Coupled Extra Strong Steel* Casing (Ref. 8)	2 1/2	2.875	2.323	0.276
	3	3.5	2.9	0.300
	3 1/2	4.0	3.364	0.318
	4	4.5	3.826	0.337
	5	5.63	4.813	0.375
	6	6.625	5.761	0.432
	8	8.625	7.625	0.500
	10	10.750	9.750	0.500
	12	12.750	11.750	0.500

* Add twice the casing wall thickness to casing O.D. to obtain the approximate O.D. of the external pipe couplings.

ATTACHMENT A
DRILLING EQUIPMENT SIZES
PAGE TWO

Drilling Component	Designation or Hole Size (Inches)	O.D. (Inches)	I.D. (Inches)	Coupling I.D. (Inches)
Flush Coupled Casing (Ref. 7)	RX	1 7/16	1 3/16	1 3/16
	EX	1 13/16	1 5/8	1 1/2
	AX	2 1/4	2	1 29/32
	BX	2 7/8	2 9/16	2 3/8
	NX	3 1/2	3 3/16	3
	HX	4 1/2	4 1/8	3 15/16
Flush Joint Casing (Ref. 7)	RW	1 7/16	1 3/16	
	EW	1 13/16	1 1/2	
	AW	2 1/4	1 29/32	
	BW	2 7/8	2 3/8	
	NW	3 1/2	3	
	HW	4 1/2	4	
	PW	5 1/2	5	
	SW	6 5/8	6	
	UW	7 5/8	7	
	ZW	8 5/8	8	
Diamond Core Barrels (Ref. 7)	EWM	1 1/2	7/8**	
	AWM	1 7/8	1 1/8**	
	BWM	2 3/8	1 5/8**	
	NWM	3	2 1/8	
	HWG	3 7/8	3	
	2 3/4 x 3 7/8	3 7/8	2 11/16	
	4 x 5 1/2	5 1/2	3 15/16	
	6 x 7 3/4	7 3/4	5 15/16	
	AQ (wireline)	1 57/64	1 1/16**	
	BQ (wireline)	2 23/64	1 7/16**	
	NQ (wireline)	2 63/64	1 7/8	
	HQ (wireline)	3 25/32	2 1/2	

** Because of the fragile nature of the core and the difficulty to identify rock details, use of small-diameter core (1 3/8") is not recommended.

STANDARD OPERATING PROCEDURE

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, scoopula, coring device, trier, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan or bowl
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling.*

B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight (``hammer'') dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for analysis normally are not collected from thin-walled tube samples.

IV. Attachments

ASTM D 1586 *Standard Penetration Test Method for Penetration Test and Split-Barrel Sampling of Soils*

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils*

V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough.
- Check that sample collection is swift to avoid loss of volatile organics during sampling.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide a general guideline for Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to procure utility subcontracting services that meet the needs of individual activities and projects.

This SOP identifies the different utility locating scenarios Activity Managers may face at their activities and spells out the general approaches that should be followed under each scenario to maximize our ability to avoid hitting underground utilities and to minimize liabilities and health and safety risks to CH2M HILL and its subcontractors.
This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

The scope of CH2M HILL's utility locating work at each Activity will depend greatly on:

- The utility locating services provided by the Activity. The public works center (PWC) or similar organization at some Activities will provide some degree of utility locating services ranging from comprehensive geophysical surveying to simply providing maps. Most of these services are provided in the form of dig permits which are required before you can dig or drill.
- The degree of faith you can put on the quality/thoroughness of the utility-locating and mapping services provided by the Activity. (I.e.: Does the PWC simply rely on their maps to mark utilities or do they verify mapped locations with field geophysics or other surveys?)

Generally we will find ourselves in one of three scenarios at an Activity:

Scenario 1

The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages that may occur if there services are inaccurate. An example of this is Patuxent River NAS.

Scenario 2

The Activity does not get involved in any utility locating processes aside from providing the most recent maps. Examples of this are Indian Head and Carderock.

Scenario 3

An intermediate situation where the Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they may want us to assume liability, they do not field verify and mark utilities, we notice mistakes in their work, etc.). An example of this is Washington Navy Yard.

The general procedures to be followed in each of these three situations are outlined in **Part IV. Procedures and Guidelines** of this SOP. Other qualifying factors that the PM needs to consider in determining what type of effort and budget will be required for utility locating are:

- What are the types and density of underground utilities in the area of the proposed work? (Are you drilling in an open field or a city street?). Utility locations would not be necessary in completely undeveloped areas such as woods. Although we need to be convinced (from historic air photos and site records) that these areas did not have historic uses that may have involved underground utilities.
- What is the history of the area? (A recently developed area of an Activity is likely to have more accurate mapping than an area that has been active for a long time.)
- How fixed are your drilling/digging points? (If you know exactly where you are going to be drilling ahead of time you can simply clear relatively small areas. If you will be revising locations in the field as an investigation progresses you will need to clearly mark larger areas or keep a utility location service on call (or at the site) to clear each location as it is identified.)

III. Services and Equipment

This section identifies provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should look for in the work done by PWC and what we should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment A provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment B provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being used by a subcontractor or PWC is adequate.

IV. Procedures and Guidelines

This section presents general procedures for each of the three scenarios identified above in Section II. This assumes that the Activity Manager has already met with PWC, established a contact and evaluated their procedures for identifying underground utilities.

Scenario 1 - Adequate Services are Provided by Activity PWC

1. Identify PWC's procedures, information needs, and time requirements for obtaining dig permits (or equivalent).

2. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps.

3. Provide PWC with information needed for obtaining dig permit.

4. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).

5. Perform a field check prior to drilling/digging to see if field utility markings coincide with locations on utility maps. If utilities shown on maps are not shown in field markings, notify PWC or Miss Utility.

Scenario 2 – Activity PWC Provides Little or No Services

1. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps. Determine if there are any unmapped utilities or public utilities on the base.

2. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).

3. If you know the locations of the borings beforehand and plan to use a locator subcontractor to clear the immediate vicinity of each proposed boring only, follow

steps 3a through 3c then go to Step 5. If you need to clear or mark a large area (all or part of a site), skip Steps 3a through 3c and go to step 4.

3a. All known subsurface boring locations should be positioned on a map to avoid known underground utility lines at the site (based on the most accurate maps available). This positioning is accomplished by using figures that show all utilities. These maps should be used as working drawings and kept in the field for use during all intrusive activities.

3b. Field locate the proposed boring locations and mark and label them on the ground (e.g. with stakes, paint, or similar markers). In a well developed area with good maps, field locating can be done by measuring from surface features that appear on the maps (building corners, manholes, etc). Distances from at least two features should be recorded on the map to insure that boring locations can be relocated if stakes or other location markers are tampered with. In areas where there are few surface features to reference and measure from, and where we have maps/GIS with good horizontal controls, proposed boring locations should be identified and field located using horizontal coordinates. In this case, a GPS unit will be required to stake boring locations in the field.

3c. When you are in the field marking boring locations check to see if there is evidence that any nearby utilities (within 50 feet of the proposed boring) are where they are shown on the maps. Look for manholes to check storm sewer and sanitary sewer lines, valve boxes and fire hydrants to check water lines, lamp posts or lighted signs to check electrical lines. For utilities such as gas, telecommunications, and many electrical service lines there may be no evidence on the surface. In this case, identify horizontal coordinates of at least two points along the utility line on the map. (this assumes we have the utilities shown accurately on maps with coordinates that can be easily read - i.e.: GIS) and mark them in the field. This can serve as a check for the utility locator's work.

4. If you need to clear or mark a large area (all or part of a site), delineate the area to be cleared/marked on a site map that includes all known utilities. If the area is not easily distinguished in the field, it may be necessary to stake out the extent of the proposed clearance work with stakes, paint, or other suitable markings. Identify all known types of utilities that may be present in the area.

5. Procure a utility locating subcontractor using the guidelines provided in Attachments A. Provide the subcontractor with copies of the utility maps as part of the procurement package and clearly identify the types of underground utilities and areas that they will be required to identify/mark.

6. Using an appropriate geophysical method selected for the types of utilities or subsurface structures expected, have the subcontractor conduct a geophysical survey within an appropriate area (See steps 3 and 4) and using an appropriate traverse around and over the proposed subsurface boring location(s) to locate any underground utility lines or structures. If clearing of individual drilling/digging locations is desired, it is suggested that the geophysical survey focus on marking all mapped utilities within a 30 foot radius of each proposed location (by tracing lines)

and doing a sweep for potentially undocumented utilities within a 10 foot radius of each proposed location. If all potential drilling/digging locations are not known up front, (such as with a typical Geoprobe investigation) the PM can either have the subcontractor sweep for and mark utilities throughout the entire area that may be addressed by the investigation up front or, keep the subcontractor on call to clear/sweep individual drilling locations as they are identified. Costs will factor in to this decision.

In areas that have only recently been developed, and complete utility as-built maps are available, it may be adequate to simply do a geophysical trace and mark the mapped utilities in the field as opposed to sweeping the entire site of each specific location.

The subcontractor should be required to use the industry standard color codes for marking utilities. See Attachment C.

7. Make note of the apparent difference between the underground utility lines and structures staked by the land survey and the corresponding underground utility lines and structures located by the geophysical survey.

8. Adjust proposed sample locations in order to avoid all subsurface utilities detected during the survey. Conduct an additional confirmatory geophysical survey at the new proposed sample location, if necessary.

9. Obtain copies of all geophysical data recorded by the geophysical surveying subcontractor, along with the subcontractor's report, if necessary. At a minimum the subcontractor should be required to mark his findings on the ground in the field with paint and provide a markup of the utility map with notes identifying what was found and where, with ties to site features.

10. The Project Manager and the Activity Manager should decide how the geophysical data will be used, in addition to its use in adjusting the proposed subsurface boring locations in the field. Geophysical data may also be recorded by professional land survey and uploaded into the Activity's GIS. You may also request the subcontractor to survey in the located utilities and create a map for future use by CH2M HILL. However, Project Managers and Activity Managers should be aware of the inherent limitations of precision and accuracy of geophysical data. In particular, the differences in the precision and accuracy of geophysical data and professional land survey data must be considered before the best use of the geophysical data is determined. **If you are being scoped to make or correct utility maps that will be provided to the navy, special precautions need to be taken to avoid the misuse of the maps and avoid exposing CH2M HILL to unreasonable liability. Requests for this type of work must be reviewed by CH2M HILL's Navy CLEAN Project Delivery Manager and Contracts Administrator.**

Scenario 3 - Activity PWC Provides Some Services, but Quality is Questionable

Under this scenario we should follow the same procedures as we would for Scenario 2, particularly if the Activity does not accept liability for mismarked utilities. Less extensive procedures on our part may be acceptable in portions of the facility where we are convinced that PWCs records (mapping) or knowledge is likely to be good.

IV. Attachments

A - Services Available for Identifying and Marking Underground Utilities
B – Equipment Used for Identifying Underground Utilities
C – Utility Marking Color Codes

Attachment A - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by us)

Each are discussed below.

Navy Public Works Center

A Public Works Center (PWC) or Public Works Department (PWD) is usually present at each Activity. The PWC is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWC has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWC is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWC in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWC, the PWC may not have a written permit process in place, or the PWC may not take responsibility for utility locating and mark-outs. In these cases, the PWC should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWC should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWC, either directly or through the LANTDIV/EFACHES NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the "One Call" service centers for each state is presented on the web at http://www.underspace.com/refs/ocdir.htm. For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	www.onisi.com/onisi/msutil/default.htm	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.greensboro.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies. The level of geophysical surveying support needed for each project will vary depending on which of the three situations described in SOP we find ourselves in:

1. The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages (Scenario 1 as described in the SOP).

In this situation, CH2M HILL will normally not need to subcontract additional geophysical surveying support for utility-locating. However, the project manager and field personnel should work closely PWC to position proposed subsurface boring locations clear of all known active and inactive utilities.

2. The Activity does not get involved in any utility locating processes aside from providing the most recent maps. An example of this is NAB Little Creek (Scenario 2 as described in the SOP).

   In this situation, CH2M HILL will require geophysical surveying support for utility-locating and subsurface sample location clearance. The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

3. The Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they want us to assume liability, they do not field-verify and mark utilities, we notice mistakes in their work, etc.) (Scenario 3 in the SOP).

   In this situation, CH2M HILL may require geophysical surveying support for utility-locating, depending on the nature of the site. At sites where no utilities are expected to exist and the utility location effort is simple, this level of support from the Activity may be acceptable. However, it will be important for the project manager to be familiar with the exact services that were provided by the Activity. At more congested sites where several utilities are known to exist, the project manager may decide to procure the services of a geophysical surveying subcontractor to supplement the Activity's efforts. In this case, the liability issues for damage to subsurface utilities should be clearly defined. For projects where geophysical surveying services are being procured for field activities other than utility-locating, it may be relatively inexpensive and efficient to have the geophysical surveying subcontractor to include the necessary utility-locating effort in the scope of work for the project to supplement the Activity's effort.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment B – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being used by a subcontractor or PWC is adequate.

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most newer lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment C – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers)*.

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the protective casing. If no reference is clearly visible, measure the depth to water from the northern edge of the riser. If access to the top of the riser is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also measure and record the three following readings: (1) the depth of the piezometer or well; (2) the distance from the reference point to the top of the protective; and (3) the distance to the surface of the concrete pad or to ground. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

Appendix C
Data Management Documents

DRAFT

DATA MANAGEMENT PROCESS OVERVIEW FOR THE NAVY CLEAN PROGRAM

Prepared 5 May 2006

Prepared by

CH2MHILL

Contents

1.0 Introduction

This Data Management Process Overview summarizes CH2M HILL's data management protocol in support of the Navy Clean Program.

The Overview is broadly applicable to the management and dissemination of data generated during environmental investigations. It is intended to be a living document and will be amended or revised to accommodate changes in the scope of environmental investigation or data management requirements.

During field investigations for the Navy Clean Program, CH2M HILL will collect a variety of environmental information that will support data analysis, reporting, and presentation. To ensure quality assurance/quality control (QA/QC) and meet current regulatory requirements, a complete audit trail of the information flow must be established. Each step in the data management process (data collection, storage, and analysis) must be adequately planned, executed, and documented. This Overview will describe in detail the specific processes that will be used by the Data Management team to capture, perform QA/QC reviews, manage/track and report the data associated with the Navy Clean Program.

This DMP is composed of 8 sections. Section 1 of this document introduces the Data Management Process. Section 2 discusses the organization of the CH2M HILL EIMS team. Section 3 discusses the data management role in Project Planning and Setup. Section 4 describes the data management role in Sample Collection and Management. Section 5 discussses the data management activities involved in Lab Analysis. Section 6 describes the data management role in Data Validation. Section 7 discusses the activities involved in Data Management. Section 8 describes Data Evaluation and Reporting procedures. Appendix A presents tables summarizing and assessing current data management materials.

2.0 Data Management Team Organization

The CH2M HILL data management team will work together to properly execute the data management process. The team model presented here is based on a Project Manager supported directly by key technology staff. The functional responsibilities of the team are described below. The responsibilities are identified by titles but not necessarily individual staff positions. The workflow among the members of the data management team is shown in Figure 1.

The Activity Manager (AM) and **the Project Manager (PM)** are responsible for preparing the work plan, schedule, milestones, and coordinating efforts with the client. The AM/PM may or may not have adequate skills to guide the data management driven aspects of their project. While the AM/PM must be willing to accept guidance from the technology leaders, they do not need to possess the technology skills as a background. The PM also responsible for ensuring data quality and is brought into the team to perform data QA/QC at various times during the data management process.

The Environmental Information Specialist (EIS) assigned to the project team is responsible for the coordination of new or existing data generated by field activities or provided by laboratory analyses. The EIS oversees contracted analytical and data validation services, ensures that analytical data are complete and consistent, enters field data results into the **Field Data Entry Tool(FDETool)**, and assists the Database Specialist in resolving any data ambiguities. The EIS will conduct verification activities following receipt of electronic data and participate in QA/QC activities to resolve inconsistencies as necessary. The EIS acts as a liaison between the Database Specialist, the PM, and the Project Chemist.

Database Specialists load data into the Environmental database. This includes analytical results from laboratory electronic data deliverables and field data results that have been entered by the EIS into the **FDETool**. The Database Specialists work with the EIS, Program Database Coordinator, and Program Data Management Coordinator to ensure that the data are loaded successfully and following established program standards and procedures.

The Field Team Leaders (FTLs) help prepare the work plan and implement the plan in the field. FTLs assign staff members to sampling teams; assign responsibilities to team members; prepare for and coordinate sampling activities; oversee the collection, recording, and documentation of the field data; and ensure that the chain-of-custody form is completed correctly.

The Project Chemist prepares the laboratory and data validation subcontracts, ensures that the electronic data deliverable was provided in accordance with the contract, assists the EIS in communicating with laboratories and data validators as needed, assists the EIS in interpreting analytical results, assists in designating CAS Numbers to new analytes, and maintains the regulatory criteria in the database.

A Program Database Coordinator (DBC) has overall responsibility for the design, operation, and maintenance of the Environmental Database. The DBC is responsible for the implementation, and evaluation of standard operating procedures to ensure integrity of the enterprise-wide database system. The DBC works directly with the Database Specialist to coordinate the different activity data and to enhance the database tools, and structure as required to increase performance and efficiency for the entire program

The Program Data Management Coordinator (DMC) is responsible for the CH2M HILL data management process at all Navy bases. The DMC manages and tracks data management personnel schedules and deliverables for the Navy program; interacts with the EIS on all aspects of data management activities; provides guidance and coordination to the EIS during resolution of data inconsistencies; coordinates completion of data queries for reports; coordinates database modification efforts with the DBC; is responsible for designing, developing, and implementing standard data entry and data retrieval tools; and leads the data management continuous process improvement investigation.

The IS Operations Lead monitors workload across all IS activities (GIS, Web, and Database) for resource and schedule conflicts, and works with IS resources to make recommendations for process change and improvement.

The IS Program Lead serves as the primary point of contact for the Navy regarding IS issues, coordinates resource requirements with regional the IS Staffing Lead, and provides direction and management to the DBC, DMC, and IS Operations Lead.

3.0 Project Planning & Setup

3.1 Attend the Kick-Off Meeting

Review the **Project Instructions**, assign sample nomenclature, go over the EIS level of effort needed and budget with the PM. Complete **the EIS Questions to Ask at Start of Project** Form and **EIS DM Budget Tracking** Form. Enter project information into the **Projects Currently in DM Tracking Table** at the link \\orion\proj\CLEANII\DATAMGMT\EIS\Projects_Currently_in_DM.xls. This tracking table should be updated/verified daily throughout the data management process.

3.2 Aid in Lab and Data Validator Acquisition

As requested, assist with the creation of the Lab Engineers Estimate, Lab Bidsheet, Lab RFP, Lab Statement of Work (SOW), and the Data Validation Engineers Estimate, Data Validation Bidsheet, Data Validation RFP, and Data Validation SOW based on the **BOA Rates Spreadsheet** and **Established Document Templates**. Submit these documents to the site Project Chemist for review and approval before they are submitted to Contracts.

3.3 Aid in Field Preparation

Inform the lab of sampling schedule. Coordinate with the lab how and when samples will be delivered to the lab (pick up, overnight, drop off). Ensure that the lab is aware of the required turn around times. If requested, order bottle ware and create sample labels. If requested, once the bottles have arrived, review the order to ensure the proper amount and type of equipment has arrived.

Tools Involved in Project Planning and Setup
BOA Rates Spreadsheet EIS Questions to Ask at Start of Project Form EIS DM Budget Tracking Form Established Document Templates Project Instructions Projects Currently in DM Tracking Table

4.0 Sample Collection & Management

4.1 Communication with Field Staff and Lab

Communicate with field staff daily during the field event. Help resolve issues that arise in the field (bottle ware shortage, equipment failure, etc). Inform the lab of the shipment dates and the number of coolers or samples being sent. Ensure samples were received in good condition (no breakage, within holding time, within designated temperature). Notify field crew and PM if there were problems with shipment.

4.2 Sample and Documentation Tracking

Create a **Sample Tracking Sheet** and update it as samples are collected using Project Instruction Tables, Chains of Custody (COC), and Lab Login Reports. The **Sample Tracking Sheet** should be updated and kept current throughout the data management process. Perform a 100% Quality Check (QC) on COCs received from the field crew. Inform field crew and/or lab if corrections need to be made. Verify that confirmation sheets/login reports from the lab contain correct information. Coordinate efforts with the lab if information needs to be corrected. As needed, create and file a **Corrections-To-File Letter**. Track samples throughout the data management process. Ensure that labs and validators deliver the Sample Delivery Groups (SDG) on time. Inform the PM if SDGs are late, and remind the lab of late penalties (if any are in place).

All documentation acquired during the data management process, including SOWs, Bids, COCs, Field Notes, **Sample Tracking Sheets**, Login Reports, **Corrections-to-File Letters**, FDETool QC tables, **Post Load Reports**, Invoices, and Communication Logs shall be compiled throughout the process and stored in the appropriate Activity's Project Notebook.

4.3 Field Data Entry Tool

The **FDETool** can be completed at any time during the sampling event timeline, and will be turned in with the data load. After the lab has received the samples and submitted login reports, complete the **Data Request/Needs Form** and email it to the Database Specialist and copy the DMC and back-up Database Specialist to request the **FDETool**. Enter data into the **FDETool** using the **Sample Tracking Sheet**, field log books and COCs. Be as specific as possible with the information entered (check with the PM and/or FTLs if information to be entered is unclear). Once all field data has been entered, run the **FDETool** output reports and QC them according to the **FDET Instructions for Data QC Form** (\\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Reference_Documents). Send the reports to another EIS or PM to review for accuracy.

Northing and Easting information should be requested from the PM, if it is missing in the **FDETool**. This data should be entered into the **FDETool. However, if the FDETool is not**

being utilized, the Northing and Easting data can be formatted into a spreadsheet format, which can be sent along with the load. All stations that have coordinates must be loaded into EnDat, even if GIS has received the coordinates. See the **Survey Coordinates Flowchart** at \\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Forms.

4.4 Track EIS Budget

Use the **EIS DM Budget Tracking Form** to track the number of hours spent on each task as they are performed. Inform the PM if the budget may be exceeded.

Tools Involved in Sample Collection & Management
Corrections to File Letter
Data Request/Needs Form
EIS DM Budget Tracking Form
FDET Instructions for Data QC Form
Field Data Entry Tool (FDETool)
Sample Tracking Sheet
Survey Coordinates Flowchart

5.0 Lab Analysis

5.1 QC Lab Data

Verify that the hard copy data and **Electronic Data Deliverables (EDDs)** are complete and acceptable as outlined in the **EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form**. Run a quality check on the EDD columns to ensure basic quality. Perform a 10% check of the analysis results. Ensure that the hard copy data matches the EDD. If errors are found, inform the PM and request corrected data from the lab.

5.2 Communicate with the Lab

Should the EDD be missing data, contact the PM and coordinate efforts with the lab to receive the missing data.

5.3 Run Tables

Communicate with the PM to determine if preliminary raw and detects tables are needed. Should tables be desired, verify the requirements and formatting (i.e. headers, footers, or other special needs) to be included on the table. Run the **Raw & Detects Tables from Unvalidated or Validated EDD Macro** on data in the EDD to create tables to assist the PM with a preliminary data analysis. A separate table must be created for EACH matrix (solid/aqueous) and sample purpose (Normal, Blanks). Ask the PM how the tables should be run before beginning.

5.4 Hard Copy Management

If data are to be validated, follow the instructions for Hard Copy Management in the Data Validation section, below. If data are not to be validated, hold on to the hard copies until project closeout/completion. After all corrections identified through the data management process have been completed (if any), the final report written, and the project determined complete, gain approval from the PM to archive the hard copy. Note, skip to section 7.0, Data Management, for EDDs that are not to be validated.

5.5 Hard Copy Archiving

If data will not be validated, fill out the **Data Archiving (List of Contents) Form,** located at the link \\Orion\PROJ\CLEANII\DATAMGMT\EIS\Data_Archiving, for each SDG, and attach it to the data packages. Once the PM has granted approval for hard copy archiving at project completion, give the boxes of data to the Data Archiving Specialist. The data will be prepped for archiving and filed within the building until the Data Archiving Specialist has received authorization to send the data to storage.

Tools Involved in Lab Analysis
Data Archiving (List of Contents) Form EDD EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form Raw & Detects Tables from Unvalidated or Validated EDD Macro

6.0 Data Validation

6.1 Hard Copy Management

If data are to be validated, the hard copy data, **EDDs**, and a **QC Association Table** will need to be mailed or emailed to the data validator. Photo copy the Form I Summary Package (which should be provided by the lab) before mailing the hard copy, to keep on file while the complete packages is with the validator. Fill out the **Data Archiving (List of Contents) Form** for each SDG, and attach it to the data packages. The **QC Association Table** is created using the COCs, field notes, and the field crew to ensure accuracy. Further instructions on the QC table are located in the form "**QC Association Table**", under

\\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Forms. The **QC Association Table** can be emailed to the data validator along with the EDD. If sending more than one EDD, prepare the EDDs to the validator's preference (i.e. one large file or divided by SDG).

6.2 Communicate with Validator

Let the data validator know ahead of time when to expect data. Inform the validator of any samples or analyses that should not be validated. (i.e. grain size should not be validated). Work with the data validator to coordinate the return of the data package to CH2M HILL for archiving. Once the data package has been returned to CH2M HILL, follow the Hard Copy Archiving procedure above.

6.3 Post-Validation

Review and QC the validated data according to the **EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form**. Verify that the validated hard copy data and EDDs are complete and acceptable. Data validators should have added qualifiers to the DV_QUAL and DV_QUAL_CODE fields only. Check the values in the DV_QUAL field against the valid value choices. Perform a 100% check of the DV_QUAL and DV_QUAL_CODE fields. Ensure that the hard copy values match the EDD. Ensure that every record requiring a data validation qualifier has one (i.e. if the Lab_Qual field has a U qualifier then there MUST be a qualifier in the DV_QUAL field).

Run raw and detects tables of the combined EDD using the **Raw & Detects Tables from Unvalidated or Validated EDD Macro**. Check to make sure there are no duplicate results for any of the samples. Send the raw and detects tables, validation report, and validated EDD to the Project Chemist for a "Pre-Load Check."

Tools Involved in Data Validation
Data Archiving (List of Contents) Form EDD EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form QC Association Table

7.0 Data Management

7.1 Load Preparation

Compile the validated SDG **EDDs** into one Excel file, if they are not formatted as such already. Add in and populate the additional columns CTO, Lab, and Validated at the end of the EDD. Add in a column before Prep_Method called Preparation. Copy and paste the data from Analysis_Method into the Preparation column. Rename the Prep_Method to CH2M_Code, and populate with appropriate valid values. Save the Excel file as an 'Archive EDD' under a new name with the project or event and the date sampling (i.e. "3_CP_CTO-244_GW&SO_103103_ ARCHIVE.xls"). Be as specific as possible when saving the file, as it will become the Archive EDD file.

Create a duplicate copy of the Archive EDD file and save it as the Load EDD (i.e. "3_CP_CTO-244_GW&SO_103103_ LOAD.xls"). In the Load EDD, delete out the surrogate records by deleting ALL records that have a value in the "Result_Type" column. Delete Lab QC Records by deleting ALL records that have a value in the "Lab_QC_Type" column. Remember to save the Load EDD once the modifications are complete.

After the data has been loaded, incorporate any corrections made to the Load EDD by the Database Specialist into the Archive EDD. Mail a copy of the Archive EDD to the DMC to be stored in the archive file (\\orion\proj\CLEANII\DATAMGMT\EDD_Archive).

7.2 Run a Pivot Table

As needed, follow the **Analyte Pivot Table Instructions** file to determine if any analytes are classified under more than one analysis group in the Load EDD. (This step is considered a backup check, as a 'Preferred Analysis Group Check' was performed on the unvalidated EDD, as specified on the **EIS QC Checklist for Unvalidated and Validated EDD and Hard Copy Data Form**.) Use the **Preferred Analysis Group Form** as a reference to assign UNREJECTED results to the correct analysis group for these analytes. If an analyte is not on this list then ask a chemist for assistance and update the **Preferred Analysis Group Form** accordingly.

7.3 PM Review of Data Load

Provide the PM with the cross-tabulated raw and detects tables created from the validated data above, and the Load EDD file. Also ask the PM if they would like a copy of the **Sample Tracking Sheet** or **Project Instructions** to assist with the review.

7.4 Email Data Load

Send the QC'd Load EDD file (the version WITHOUT the surrogate and QC data) and **FDETool** in an email to the Database Specialist for loading into EnDat, and copy the DMC and back-up Database Specialist. In the email, attach an electronic copy of the completed **Data Request/Needs Form** with the following information completed:

- Program Name (ex: Clean II)
- Activity (ex: Little Creek)
- Contract Task Order (CTO)
- Prime Contractor (company responsible for providing a product to the Navy)

- Field Contractor (company who performed the field work)
- Was the data upload scheduled with the DB staff?
- Is the data validated?
- Data Validator Name (If no DV then who within CH2M HILL evaluated the data?)
- Number of samples
- Dates of the sampling event
- Number of records in EDD
- Requested Due Date
- Any Reports Requested?

The Database specialist will then conduct any additional formatting modifications to the EDD as needed to load the data into EnDat.

7.5 Post Load

The Database Specialist shall generate **Post Load Reports** and provide them to the EIS for review and QC. Once the **Post Load Reports** have been QC'd by the EIS, the EIS will then send the reports to the PM for review. Inform the PM of any corrections that need to be made, and coordinate these changes with the Database Specialist. Any changes made to the data by the Database Specialist prior to load, or that will be completed after the load should be tracked, and incorporated into the hard copy and EDD files that are to be archived after project completion.

Tools Involved in Data Management
Data Request/Needs Form
EDD
Field Data Entry Tool (FDETool)
Pivot Table Instructions
Preferred Analysis Group Form
Project Instructions
Raw & Detects Tables from Unvalidated or Validated EDD Macro
Sample Tracking Sheet
Post Load Reports

8.0 Data Evaluation & Reporting

8.1 Run Tables

Meet with the PM to verify table requirements and formatting (i.e. headers, footers, or other special needs). Raw and detects tables must be created for EACH matrix (solid/aqueous). Pull the data from **EnStat**. There are three macro templates that can be utilized to assist with the formatting of EnStat output files. These include the **Raw, Detects, & Exceedance Tables from EnStat Output Macro**, **HHRA Tables from EnStat Output Macro**, and **EcoRisk Tables from EnStat Output Macro**.

Run the **Raw, Detects & Exceedance Tables from EnStat Macro**, and send the completed tables to the Project Chemist for a final quality check. Provide the completed, QC'd tables to the PM. Other tables can be generated from the remaining macros as requested.

8.2 Review Laboratory and Validator Invoices

Laboratory invoices should be submitted once the laboratory has completed requested analyses, and submitted all results and requested corrections. Data validation invoices should be submitted shortly after the validation has been completed, and the report submitted to CH2M HILL. Invoices will be submitted to the PM through AP Workflow for approval. The PM should then consult the EIS for invoice review before submitting approval. The EIS should review the invoices, and noting any late charges, etc, and update the **Sample Tracking Sheet** accordingly.

8.3 Complete EIS DM Budget Tracking Form

Meet with the PM and the DMC to review the **EIS DM Budget Tracking Form** and discuss lessons learned.

Tools Involved in Data Evaluation & Reporting
EcoRisk Tables from EnStat Output Macro EIS DM Budget Tracking Form EnStat HHRA Tables from EnStat Output Macro Raw, Detects, & Exceedance Tables from EnStat Output Macro Sample Tracking Sheet

Appendix A

Summary & Assessment of Data Management Materials

Summary Of Tools Involved In The Data Management Process

Tools	Assessment
BOA Rates Spreadsheet	This is only updated every 5 years. We need an SOP to remind EISs to add a 10% increase for each year after the update year until it is updated again.
Corrections to File Letter	
Data Archiving (List of Contents) Form	Kevin McGarvey, the Archiving Expert will be working in the WDC office through June, and will be stopping by here. He could be tasked to write up an SOP. We might have some mini-SOPs to work from too.
Data Request/Needs Form	Good
EcoRisk Tables from EnStat Output Macro	Good
EDD	Good, though primary keys need revision.
EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form	This is a good procedure checklist, and could easily be made into a formal SOP.
EIS Questions to Ask at Start of Project Form	This could use a few formatting tweaks, but is generally good as is.
EIS DM Budget Tracking Form	This should be updated to incorporate all the aspects of the data management process for more accurate tracking
EnDat Post Load Reports	Good. Used to assess and QC data loaded into EnDat to ensure data load accuracy and completeness
EnStat	This needs work to get it running better/correctly. There is a ppt presentation on using this that could serve as a SOP.
Established Document Templates	Currently we work off of pre-existing docs, which vary. Templates must be established.
FDET Instructions for Data QC Form	Needs evaluation
Field Data Entry Tool (FDETool)	Could use a bulk upload function, and built in QC checks

Tools	Assessment
HHRA Tables from EnStat Output Macro	Needs evaluation
Pivot Table Instructions	Could easily be made into a good SOP
Preferred Analysis Group Form	Good
Project Instructions	From PM
Projects Currently in DM Tracking Table	Good
QC Association Table	The example on the server is intended to use as a template, and could use a little tweaking
Raw & Detects Tables from Unvalidated or Validated EDD Macro	This macro could use formatting updates. There is no SOP for this, but I do have a rough mini-SOP that Felicia wrote up.
Raw, Detects, & Exceedance Tables from EnStat Output Macro	Needs evaluation
Sample Tracking Sheet	Need to develop template
Survey Coordinates Flowchart	Good

Summary of Documentation in the Reference Manuals

Document	Assessment for Current DMP	Assessment for NIRIS
IS Personnel 11-2006	Current	Good
Load Process Step by Step	Generic overview, not SOP. Need Bhavana to write a formal SOP if desired	Need New Document
Navy Clean IS Organization	Out of Date	Need New Document
Reference Manual Binder Covers	Current	Good
Ref Manual Page Dividers	Current	Good
Project Manager Role in IS-DM Process	Current	Good
Environmental Information Specialist Role 1	Current	Good
Data Management Coordinator Role	Current	Good
Navy Clean Data Management Process Flowchart	Current	Good
Survey Coordinates Flowchart	Good	Needs Revision
Life of a Sample Flowchart	Needs Revision	Needs Revision
Chemicals in EnDat 010306	Needs periodic updates	Need New Document
Chemical Synonyms in EnDat	Needs periodic evaluation	Need New Document
Common Chemical Synonyms & Abbreviations	Good	Good
Analyses and Methods Commonly Used	Needs periodic updates	Needs periodic updates
FDET Valid Values	Good	Need New Document
Lab Valid Values	Good	Need New Document
DV Valid Values	Good	Need New Document
Field Sample Naming Scheme	Needs Revision (to Sample Nomenclature Protocol for all Bases)	Uncertain
Field Station Naming Scheme	Needs Revision (to Station Nomenclature Protocol for all Bases)	Uncertain
EDD Format CH2M Navy 120605	Needs Updates	Need New Document

Document	Assessment for Current DMP	Assessment for NIRIS
DCLT Manual	None – This is no longer used, as the Tool is broken	Delete
STS Example	Need to develop template	Need to develop template
Corrections To File	Good	Uncertain
Corrections to File Example	Good	Uncertain
FDET Instructions	Good	Delete
FDET Screen Shot	Good	Delete
FDET Stations Report Example	File does not exist	Delete
FDET Sample Report Example	File does not exist	Delete
FDET Field Results Report Example	File does not exist	Delete
FDET Full Detail Report Example	File does not exist	Delete
FDET Result Report in XL Example	Good	Delete
FDET Instructions for Data QC	Needs Evaluation	Delete
Data Management Checklist _rev0306	Needs Revision	Needs Total Revison/Rewrite
Analyte Pivot Table Instructions	Good	Uncertain
Analyte Pivot Table Example	Can not locate file	Uncertain
Preferred Analysis Group	Needs evaluation – have older version (ABL) too	Uncertain
Ex of Pre-Load QC Raw & Detects Tables	Good	Need new document
Ex of Post-Load Station Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Sample Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Field Result Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Analysis Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
EnStat Tool Instructions	PPT, not SOP. Could easily be made into SOP	Need New Tool
EnDat Threshold Criteria	Needs Evaluation	Need New Document
Definitions of RBC & MCL Threshold Variations	Unable to locate Email Doc	Uncertain

Document	Assessment for Current DMP	Assessment for NIRIS
Ex of Unformatted EnStat Post-Load Tables	Good	Need New Document
Ex of Formatted EnStat Post-Load Tables	Good	Need New Document
IS Costing Template 2006Rates 042506	Needs to be Updates	Needs Updating
IS Data Request-Needs Form	Good	Needs Update/New Document
Quarterly Sampling Projection Forms Example	Good	Good
EIS Project Startup Questions_rev0905	Good	Needs Revision
EIS DM Budget Tracking Form	This should be updated to incorporate all the aspects of the data management process for more accurate tracking	Needs Revision
EIS QC Checklist for Unval & Val EDD & Hard Copy Data	Unable to locate document	Needs Revision
EIS Training Checklist	Good	Needs Revision

Data Management Checklist

Base Name:_________________________ **CTO Number(s):**_____________________

Site:________________________________ **PM:**________________________________

Sample Date Range:__________________ **EIS:**________________________________

Lab:________________________________ **DV:**________________________________

SDG #'s:____

☐ **Attend Kick-off Meeting** (Review project instructions, assign sample nomenclature, go over the EIS level of effort needed and budget with PM). Determine EDD format to be used.

☐ **Aid in field preparation:** Inform lab of sampling schedule, coordinate with the lab how samples will be delivered to the lab (pick up, overnight, drop off) and how often, ensure lab is aware of the required turn around times. If requested, order bottle ware and create sample labels. If requested, once the bottles have arrived, review the order to ensure the proper amount and type of equipment has arrived.

☐ **Communication with field staff and lab during field event:** Communicate with field staff daily. Help resolve issues that arise in the field (bottle ware shortage, equipment failure, etc). Inform the lab of the shipment dates and the number of coolers or samples being sent. Ensure samples were received in good condition (no breakage, within holding time, within designated temperature). Notify field crew and project manager if there were problems with shipment.

☐ **Sample Tracking:**

- Create sample tracking sheet and update it as samples are collected.
- Receive COCs from field crew: Perform a 100% quality check of the chains of custody (COC). Inform field crew and/or lab if corrections need to be made.
- Receive confirmation sheets from lab. Verify they have the correct information. Coordinate with lab if their information needs to be corrected.
- Generate a Corrections-to-File letter for any COC/field log book/login discrepancy. Provide a copy to the laboratory, data validator, Project Manager, and Project Notebook. (See files Instructions_Corrections-to-File, and Template_Corrections-to-File)
- Track samples throughout the data management process. Ensure that labs and validators deliver the Sample Delivery Groups (SDG) on time. Inform project manager if SDGs are late and remind lab of late penalty (if there is one in place).

☐ **Track EIS Budget:** Use the EIS Budget Tracking Form to track the number of hours spent on each task as they are performed. Inform the project manager if you suspect you will go over budget.

Pre-Validation:

☐ **QC lab data (For Specifics see EIS QC Checklist):**

- Verify that the hard copy data and EDDs are complete and acceptable. Run a quality check on the electronic data deliverable (EDD) columns to ensure basic quality.
- Perform a 10% check of the analysis results. Ensure that the hard copy data matches the EDD. If errors are found, inform the project manager and ask the lab to send corrected data.

☐ **Communication with Lab:** If there is missing data from the EDD, contact the project manager and coordinate with the lab to receive the missing data.

☐ **Run Unvalidated Tables:**

- Check with the PM to see if they would like preliminary raw and detects tables. If so, verify the needs on the table. (i.e. headers, footers, or other special needs).
- Run either the "*Raw & Detects Tables from Unvalidated or Validated EDD.xls*" or "*Raw & Detects Tables from Unvalidated or Validated SNEDD.xls*" (depending on EDD format used) macro to create tables to assist the PM in their preliminary analysis of the data.

- Create a separate table for EACH matrix and Site (solid/aqueous).– ask the PM how they would like these tables run before you start.

☐ **Hard Copy Management:** Fill out the Data Archiving Form for the lab data located at the following link and file on the top of each SDG. (\\ariadne\Proj\CLEANII\DataMgmt\EIS\Ref Manual Updating\Data_Mgmt_Manual-Spring-2007)

- The QC association table should be created using the COCs, field notes, and field crew to ensure accuracy. For further instructions on the QC table please go to the link above and select "Template_QC-Association_Table".
- If data are being validated, mail/email the hard copy data, EDDs, and QC association table to the validator. A Form I summary report should also be provided.
- If data are NOT being validated, provide the hardcopy data, EDDs, QC association table, and Unvalidated Raw and Detects tables to the Chemist for an Internal or PreLoad Check (see Chemist Preload Check section below).

☐ **Communication with Validator:** Let the validator know ahead of time when to expect data. Inform validator of any samples or analyses that should not be validated. (For example grain size should not be validated)

Field Data Entry Tool:

☐ **Data Request/Needs Form:** Following sample collection, complete the Data Request/Needs Form and email it to Bhavana Reddy/WDC and copy Mike Zamboni/WDC to request the Field Data Entry Tool (FDETool).

☐ **FDETool Data Entry:** Enter data into the FDETool using field log books and COCs. Be as specific as possible with the information entered (check with the project manager and/or Field Team Leaders if you are unsure of information.)

☐ Request Northing and Easting information from project manager if not provided. This data must be entered into the FDETool. (See file DMP_Survey-Coordinates-Workflow)

☐ **QC FDET Data:** Complete FDET output reports and QC. Send to another EIS or **project manager** to review accuracy.

☐ **NIRIS Field NEDD Output:** Output the necessary NIRIS field-related NEDDs from the FDETool if data is to be loaded into NIRIS (all projects with a SNEDD). Reserve these for after the data has been loaded into EnDat and the data is ready for archiving.

Post-Validation:

☐ **QC validated data (For Specifics see EIS QC Checklist):**

- Verify that the validated hard copy data and EDDs are complete and acceptable
- In the CH2M HILL EDD format, Data validators should have added qualifiers to the DV_QUAL and DV_QUAL_CODE fields and no other fields. In the SNEDD format, data validators should have updated the fields: Analyte_Value, Validator_Qualifier, QC_Narrative, Validator_Name, and Val_Date.
- Check all validation-related Valid Values against Valid Value Look up Tables.
- Perform a 100% check of the DV_QUAL and DV_QUAL_CODE field (or Validator_Qualifier, QC_Narrative fields in the SNEDD). Ensure that the hard copy values match the EDD
- Ensure that every record that needs a data validator qualifier has one (i.e. if the Lab_Qual field has a U qualifier then there MUST be a qualifier in the DV_QUAL or QC_Narrative field)

☐ **Run Validated Tables:**

- Run validated raw and detects tables. Verify any specific needs on the table with the PM. (i.e. headers, footers, or other special needs).

- Run either the "*Raw & Detects Tables from Unvalidated or Validated EDD.xls*" or "*Raw & Detects Tables from Unvalidated or Validated SNEDD.xls*" (depending on EDD format used) macro to create tables to assist the PM and Chemist in their analysis of the data.
- Review tables to determine which analytes are classified under more than one analysis group. Resolve discrepancies with Project Chemist. Or, run a Pivot Table to determine if analytes are assigned to more than one analysis group. Follow the "*Instructions_Analyte-Pivot-.doc*" file to determine which analytes are classified under more than one analysis group. Use the "*Form_Preferred-Analysis-Group.xls*" file as a reference to assign the **UNREJECTED** result to the correct analysis group for these analytes.
- **PM Review of Data:** Provide the tables to the PM. Also ask the PM if they would like a copy of the Sample Tracking Sheet or Project Instructions to assist them in their review.

Archive/PreLoad EDD Prep:

☐ CH2M HILL Format EDDs

- Compile the validated SDG EDDs into one Excel Archive file. In the CH2M HILL EDD format, add in additional columns CTO#, Prep_Method, and Validated. (This file will be archived) Save the Excel load file under a new name with the project or event and the date sampling began (i.e. "PAX_244_GW_Sampling_ARCHIVE_103103.xls"). Be as specific as possible when saving the file.
- For Sample_IDs with DL, RA, or RE appended (this indicates a second run on the same sample and therefore two or more sets of results), the data validator should have selected one result to be used and placed an "R" for rejected on the result(s) not to be used. Check that there is only one usable result for each analyte.
- Remove the DL-, RA-, or RE-type suffixes from all Sample_IDs. Verify that these designations are captured in the "ReRun" column before deletion.
- Conduct one quick final check for anomalies by setting filters for each column.

☐ SNEDD Format EDDs

- Compile the validated SDG EDDs into one Excel file. Save the Excel file under a new name, with the project or event and the date sampling began (i.e. "PAX_244_GW_Sampling_Validated_PreLoad_SNEDD.xls")

Chemist PreLoad Check:

☐ **Project Chemist QC of data**

- If data are NOT being validated, provide the hardcopy data, Archive or PreLoad EDDs, QC association table, and Unvalidated Raw and Detects tables to the Chemist for an Internal or PreLoad Check. Verify that the validated hard copy data and EDDs are complete and acceptable
- If data have been validated, provide the hardcopy data validation report, validated EDDs, QC association table, and Validated Raw and Detects tables to the Chemist for an Internal or PreLoad Check.

Load Preparation:

☐ CH2M HILL Format EDDs

- Conduct one quick final check of the Updated/QC'd ARCHIVE EDD provided by the Chemist for anomalies by setting filters for each column.
- **Delete Surrogate Records.** Delete ALL records that have a value in the "Result_Type" column.
- **Delete Lab QC Records.** Delete ALL records that have a value in the "Lab_QC_Type" column.
- Save the EDD with the deleted records as the Load EDD. i.e. "PAX_244_GW_Sampling_LOAD_103103.xls")

☐ SNEDD Format EDDs

- Conduct one quick final check of the Updated/QC'd PreLoad EDD provided by the Chemist for anomalies by setting filters for each column. Import the file into the Archive and Load Prep Tool (ALPTool).
- Run the following functions: Import SNEDD File, Verify SNEDD File Analyte IDs, EnDat File Preparation, NIRIS File Preparation. Save the outputted EnDat Archive, EnDat Load, and NIRIS NEDD files.

☐ **Email Data Load:** Send the CH2M HILL Excel LOAD file (the version WITHOUT the surrogate and QC data) and FDETool in an email to Bhavana Reddy and copy Mike Zamboni/WDC for loading into EnDat. In the email attach an electronic copy of the completed Data Request/Needs Form with the following information completed:

- Program Name (ex: Clean II)
- Activity (ex: Little Creek)
- CTO
- Prime Contractor (company responsible for providing a product to the Navy)
- Field Contractor (company who performed the field work)
- Was the data upload scheduled with the DB staff?
- Is the data validated?
- Data Validator Name (If no DV then who within CH2M HILL evaluated the data?)
- Number of samples
- Dates of the sampling event
- Number of records in EDD
- Requested Due Date
- Any Reports Requested?

Post Load:

☐ **QC Post Load Reports:** Receive the post load reports from Bhavana Reddy or Mike Zamboni. QC reports and also send the reports to the project managers to review. Inform project managers of any corrections that need to be made. Coordinate these changes with Bhavana or Mike.

☐ **EDD Archiving:** Incorporate any corrections made by Bhavana or Mike during loading, or resolved after loading into the CH2M HILL ARCHIVE EDD, SNEDD, and NIRIS NEDD. Send both files, along with the FDETool NIRIS field-related NEDD files to Chelsea Bennet/VBO for archiving.

☐ **Run Tables:**

- Meet with the PM to verify the needs on the tables (i.e. headers, footers, or other special needs).
- A raw and detects table must be created for EACH matrix and site (solid/aqueous). Ask the PM how they would like these tables run before you start.
- Pull the data from EnStat
- Run the "*Raw, Detects & Exceedance Tables from EnStat.xls*"

☐ **Review Laboratory and Validator Invoices:** Track invoices and approval dates on the tracking sheet

☐ **Complete EIS Budget Form:** Meet with project manager and the data management coordinator to discuss lessons learned.

EDD Prep for Load and Archive Files

CH2M HILL EDDs

1. Combine EDDs into one EDD. Two versions of the EDD will be generated (I. Archive EDD, and II. Load EDD)
2. ADD 3 Columns to the end of the EDD:
   a. CTO (List the only the numerical value from the CTO, or full TO number. Ex. CTO-177 = 177, TO-45 = TO-45)
   b. Lab (Write out the complete name)
   c. Validated (T or F)
3. Rename the field Preparation as "CH2M_Code". Filter on each Analysis Group, and update this field according to the correct Valid Values for CH2M_Code. Ex. NONS for SVOA, NONE for METAL.
4. Highlight and Copy the Analysis_Method field, and insert the column before the field CH2M_Code. Rename the new field as Preparation.
5. Generate Archive EDD
   a. Save the file as the Archive EDD. Ex file name = CP_CTO-74_Site-30_SD_May-07_ARCHIVE_EDD
6. Generate Load EDD
   a. Remove Lab QC data from the EDD – Filter for non-blanks on the field Result_Type, and delete non-blank records. Filter for non-blanks on the field Lab_QC_Type, and delete non-blank records.
   b. Review the field Sample_ID and ensure that all Lab QC Samples have been removed.
   c. Save the file as the Load EDD. Ex. File name = CP_CTO-74_Site-30_SD_May-07_LOAD_EDD

SNEDDs

7. Combine SNEDDs into one SNEDD. Three file versions will be generated (I. Archive EDD, II. Load EDD, and III. NIRIS NEDD)
8. Open the ALPTool, and follow the directions and buttons listed in steps 1 through 4
   a. Step 1 – a) Click on the button 'Prepare ALPTool'. b) Click on the folder button, selected the SNEDD file to be imported from the appropriate director, and click on the button 'Import SNEDD'
   b. Step 2 – Click on the button 'Check Analyte IDs'. If any records are listed in the pop up, resolve any incorrect analyte IDs.
   c. Step 3 – a) Click on the button 'Archive EDD'. Follow the directions in the pop up to save the file. B) Click on the button 'Load EDD'. Follow the directions in the pop up to save the file.
   d. Step 4 – Click the button 'NEDD'. Follow the directions in the pop up to save the file. Click the button 'Close' to close the entire application.
9. Save Files
   a. Save the Archive EDD. Ex file name = CP_CTO-74_Site-30_SD_May-07_ARCHIVE_EDD
   b. Save the Load EDD. Ex file name = CP_CTO-74_Site-30_SD_May-07_LOAD_EDD
   c. Save the NIRIS EDD. Ex file name = CP_CTO-74_Site-30_SD_May-07_NIRIS_NEDD

EIS QC Checklist for Unvalidated and Validated EDDs/SNEDDs and Hard Copy Data

Sample Tracking Sheet/Lab Login Reports

☐ Compare COCs and STS to the Project Instruction tables to verify that the COCs and Lab Logins reflect all requested analyses. Check with PM/Lab if there are any discrepancies.

Unvalidated EDDs and Hard Copy Data

☐ Compare the analyses reported in the EDD to the STS to very that the lab has reported all requested analyses for each sample. Resolve any discrepancies with the PM/Lab/Chemist.

☐ Verify columns on the EDD match the CH2M HILL format specified; EDD or SNEDD (Header spellings, order)

☐ Check EDD/SNEDD Columns for correct Valid Values

- ☐ Sample IDs match the STS exactly
- ☐ Analysis Groups are correct (ex. Perchlorate can be WCHEM or EXPLO depending on the base)
- ☐ Dates/Times are numerical and appropriate in analysis progression (ex. Date analyzed is after date sampled)
- ☐ Chem Names and Analyte ID (CAS #)
- ☐ Ana Values (SNEDD Original Analyte Value) match appropriate Reporting Limits (Metals match MDL, all else match DL)
- ☐ Analyte Values are appended to each Parameter. (Filter for blanks)
- ☐ Units are correct for media (solid vs. aqueous)
- ☐ Result Type, Lab QC Type, Rerun and Lab Code
- ☐ Lab Code and/or Lab Name

<u>Additional SNEDD Valid Values</u>

- ☐ Contract ID, DO CTO Number, and Installation ID are correct
- ☐ CH2M_Code
- ☐ Sample Basis
- ☐ Sample Medium
- ☐ GC Column Type
- ☐ Analysis Result Type
- ☐ QC Control Limit Code

☐ EDD vs. Hard Copy Check. Perform a 10% - 20% QC on each analysis group to verify that the EDD and hard copy are an exact match. Verify results for reextraction/reanalyses are reported in Hardcopy and EDD. Resolve any discrepancies with the Lab/Chemist.

Validated EDDs and Hard Copy Data

☐ Validated EDD columns DV_Qual & DV_Qual_Code contain correct values

☐ For SNEDD format, Analyte_Values are correctly copied/updated from Original_Analyte_Value. Columns Validator_Qualifier, Validator_Name, and QC_Narrative are populated correctly

☐ EDD vs. validated marked up Form Is. Perform a 100% QC of all validated data in EDD and hard copy Form Is. Compile a list of discrepancies and request clarification from validator. Review data validation case narratives to help clarify possible mistakes.

☐ Filter on non-detects (U, UJ, UL) in the Lab_Qualifier column and verify that the validator has copied over all non-detects into the DV_Qual (or Validator Qualifier) column.

☐ Generate validated Raw and Detects tables from the Validated EDD. Provide validated tables and EDD to Chemist for PreLoad Check.

EDD Prep for Raw and Detects Tables for Unvalidated or Validated Data

1. Combine EDDs into one EDD, and save file as "Combined Unval EDD for Tbl Macro". (Note – SNEDDs and EDDs are different formats and cannot be combined together.
2. Remove Lab QC data from the EDD
    a. CH2M HILL EDD – Filter for non-blanks on the field Result_Type, and delete non-blank records. Filter for non-blanks on the field Lab_QC_Type, and delete non-blank records.
    b. SNEDD – Filter for records that do not equal TRG in the field Analysis_Result_type, and delete records. Filter for records that do not equal REG in the field Lab_QC_Type, and delete records.
3. Select and Open the correct table formatting macro
    a. CH2M HILL EDD – Open "Raw & Detects Tables From Unvalidated or Validated EDD - new EDD format- 04-12-02.xls". When prompted, select Enable Macros.
    b. SNEDD - Open "Raw & Detects Tables From Unvalidated or Validated EDD - SNEDD format – 20070413.xls". When prompted, select Enable Macros.
4. Filter out samples in the EDD or SNEDD by Site and Media
5. Copy and Paste filtered records from the EDD or SNEDD into the worksheet "DATA" the correct formatting macro. Make certain that the column formats match.
6. Indicate validated records by updating the field "Valid_YN" on the "DATA" worksheet
7. Select Input Options
    a. Indicate validation status of the data, and enter header text for the data table.
8. Run Macro
    a. Select Tools / Macro / Macros.
    b. Select and run each macro in the following order: "CROSSTAB", "RAW_FORMATTING" and "DETECT_FORMATTING".
9. DO NOT SAVE DATA INTO THE MACRO!
10. Move formatted tables to a new workbook
    a. Highlight both worksheets "Raw" and "Detects".
    b. Right click one of the worksheets
    c. Select "Move or Copy"
    d. Select "Move to New Book", and click "OK"
11. Additional Table Formatting
    a. Ensure that Borders, Column Header Fonts, and Notes section at the bottom of the table look correct. (Note – CH2M HILL EDD will require the EIS to add the Notes Section by hand)
    b. Select File / Page Setup
        i. Page - Format tables to 11 x 17 paper, landscape orientation, 80 % size
        ii. Set Margins to: Top = 1.33, Left = .75, Bottom = .5, Bottom Footer = .35, Right = .5
        iii. Header/Footer
            1. Ensure appropriate header format. Ex. TO-45, NSN-CALF, Unvalidated Groundwater Raw Analytical Results, March 2006 LTM
            2. Ensure appropriate footer. Only page number should be displayed in the right.
        iv. Sheet – Ensure Gridlines is not selected.
12. Repeat for each Site and Media.

CH2M HILL SNEDD Format			
Field Name	**Field Format**	**REQ**	**Field Description**
Contract_ID	A13	R	Contract ID assigned by Division Contracting Office: format is UIC (6 char.) + FY (2 char.) + FAR code (1 char.) + Number (4 char.). (e.g. D459559365800)
DO_CTO_Number	A4	R	CTO or TO # assigned by Navy. (e.g. CTO-12 = 0012)
Phase	A8	RA	Task Phase, SubTask Number or Annual Quarter. (e.g. QTR1)
Installation_ID	A20**	R	Unique identifier for installation. (e.g. WHIDBEY)
Sample_Name	A50	R	CH2M HILL Sample ID (from Chain Of Custody).
CH2M_Code	A4*	R	CH2M HILL Preparation Method Code (e.g. NONS)
Analysis_Group	A9*	R	The CH2M HILL code for the analysis performed on the sample.
Analytical_Method	A20*	R	Analytical Method used to analyze sample fraction. (e.g. 6010)
PRC_Code	A15*	R	NIRIS code for the analytical method category (e.g. LEACH)
Lab_Code	A10**	R	CH2M HILL Code assigned to the laboratory (e.g. SHEA)
Lab_Name	A50**	R	The name of the laboratory that conducted the analysis.
Leachate_Method	A16*	RA	Code for the leachate method used on sample. (e.g. SW1310)
Sample_Basis	A16*	RA	Sample basis of analysis; wet weight, dry weight etc. (e.g. DRY)
Extraction_Method	A16*	RA	Code for the extraction method used on sample. (e.g. FLTRES)
Result_Type	A16*	RA	Type of results; dilution, reanalysis etc. (e.g. 000)
Lab_QC_Type	A15*	RA	Code for Laboratory Sample (MS, MSD, LBLK, LCS)
Sample_Medium	A16*	R	Sample medium reported by the laboratory. (e.g. L)
QC_Level	A16*	R	QC Level of data package : EPA levels I to IV. (e.g. 3)
DateTime_Collected	MM/DD/YYYY 00:00	R	Date and time sample was collected. Use 24 hour clock. (e.g. 02/13/07 15:34)
Date_Received	MM/DD/YYYY	R	The date the sample was received in the lab. (e.g. 03/24/07)
Leachate_Date	YYYYMMDD	RA	Date the sample was leached. (e.g. March 12, 2007 = 20070312)
Leachate_Time	HH:MM:SS	RA	Time the sample was leached. Use 24 hour clock. (e.g. 14:30:05)
Extraction_Date	YYYYMMDD	RA	Date that the lab extracted the sample.
Extraction_Time	HH:MM:SS	RA	Time of day that the lab extracted the sample. Use 24 hour clock.
Analysis_Date	YYYYMMDD	R	Date that the lab performed the analysis.
Analysis_Time	HH:MM:SS	R	Time of day that the lab extracted the sample. Use 24 hour clock.
Lab_Sample_ID	A20	R	Unique ID assigned to the sample by the laboratory.
Dilution	N10,2	R	Dilution factor used. (e.g. 10)
Run_Number	N4	RA	Number distinguishing multiple or repeat analyses by the same method, on the same day. Must be equal to or greater than 1.
Percent_Moisture	N6,3	RA	Percent moisture of the sample. (e.g. 20)
Percent_Lipid	N6,3	RA	Percent lipid of the sample.
Chem_Name	A45*	R	The compound being analyzed.
Analyte_ID	A20*	R	Analyte ID (CAS Number) assigned to the analyte. (e.g. 7440-47-3)
Analyte_Value	N18,7	R	Leave Blank for Validator to enter the final analyte concentration.
Original_Analyte_Value	N18,7	R	Analyte concentration value originally generated by the Laboratory.
Result_Units	A16*	R	Unit of measure for the analyte value. (e.g. UG_L)
Lab_Qualifier	A16*	RA	Lab data qualifier. Values will not be rejected if not in domain table.
Validator_Qualifier	A16*	RA	Leave blank for Validator. Values will not be rejected if not in domain table.
GC_Column_Type	A16*	RA	Data code for the type of GC column used in an analysis.
Analysis_Result_Type	A3*	R	Type of analysis performed (allowed: TIC or TRG).
Result_Narrative	A120	RA	Additional information or comments associated with the result.
QC_Control_Limit_Code	A16*	RA	Type of quality control limit. Req'd if QC criteria included. (eg. CLPA)
QC_Accuracy_Upper	N6,3	RA	Accuracy Upper Limit. Upper QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 25.45)
QC_Accuracy_Lower	N6,3	RA	Accuracy Lower Limit. Lower QC limit of % recovery as measured for a known target analyte spiked into a QC sample. (e.g. 10.15)
Control_Limit_Date	YYYYMMDD	RA	Date a control limit is established.
QC_Narrative	A120	RA	Leave blank for Validator. Enter EnDat EDD's DV_Qual_Code.
MDL	N18,7	RA	Method Detection Limit
Detection_Limit	N18,7	RA	Reported Detection Limit
SDG	A50	R	Lab code for a group of samples in a data deliverable package.
Analysis_Batch	A20	R	Laboratory code for a batch of analyses analyzed together.
Validator_Name	A50**	R	Leave Blank. Name of Validator. (e.g. CONTRACTOR INC.)
Val_Date	YYYYMMDD	RA	Populated by Validator/Reviewer. Validation/Review QC date.

Notes:

* - See Valid Value List or Lookup Table

** - See Naval Master List. Please request from the EIS. If name is new, corresponding NEDD must be submitted by EIS.

R - Required Field

RA - Required as Appropriate

NR - Not Required

EDD to be submitted in Excel

SNEDD LAB VALID VALUES

SAMPLE ANALYSIS GROUP	
Value	**Description**
ASBESTOS	Asbestos
AVSSEM	Acid Volatile Sulfide/Simultaneously Extractable Metals
CORR	Corrosivity
DIOXIN	Dioxins
EXPLO	Explosives
FDIOX	Filtered or Dissolved Dioxins
FMETAL	Filtered or Dissolved Metals
FPEST/PCB	Filtered or Dissolved Pesticides/PCBs
FWCHEM	Filtered Wet Chemistry
GEOTECH	Geotechnical (includes Atterberg limits, consolidation, etc.)
GRAINSIZE	Grain size
HERB	Herbicides
IGN	Ignitability
METAL	Metals and/or Cyanide
PCBCONG	Polychlorinated Biphenyl (PCB) Congeners
PEST/PCB	Pesticides and/or Polychlorinated Biphenyls (PCBs)
RAD	Radiation
REACT	Reactivity (includes reactive sulfide and reactive cyanide)
SVOA	Semivolatile Organic Compounds, Base Neutral/Acid (BNA) [includes Poly-Aromatic Hydrocarbons (PAHs)]
TCLPH	Herbicide results from the leaching procedure
TCLPM	Metal results from the leaching procedure
TCLPP	Pesticide and PCB results from the leaching procedure
TCLPS	Semivolatile results from the leaching procedure
TCLPV	Volatile results from the leaching procedure
TPH	TPH (includes DRO/GRO, VPH/EPH, *or* fuel oil, mineral oil, etc.)
VOA	Volatile Organic Compounds
WCHEM	Ions, Cations, pH, TOC, BOD, TSS, oil & grease, etc.

CH2M_Code	
Value	**Description**
ENCO	Volatiles collected with Encore Samplers
FILT	Dissolved Metals
NONE	All Else, Except Semivolatiles
NONS	Semivolatile Analysis
SEM	Simultaneously Extractable Metals
TCLP	TCLP Samples

Sample Basis	
Value	**Description**
AIR	Air
CEN	Centrifuge supernatant
DRY	Dry
F	Filtered - field/lab not indicated
FF	Field Filtered
LF	Lab Filtered
N	Not filtered
NA	Not applicable
WET	Wet

Analysis Result Type	
Value	**Description**
TIC	TIC
TRG	TRG
IS	Internal standard, will be reported as % Recovery
S-I	Surrogate or Internal Standard, will be reported as % Recovery
SURR	Surrogate, will be reported as % Recovery

LAB QC TYPE	
Value	**Description**
BD1	Blank spike duplicate 1
BD2	Blank spike duplicate 2
BLK	Blank
BS	Blank spike
BS1	Blank spike 1
BS2	Blank spike 2
BSD	Blank spike duplicate
CB	Calibration blank
KD1	Reference Material Duplicate 1
KD2	Reference Material Duplicate 2
LB1	Laboratory blank 1
LB2	Laboratory blank 2
LD	Laboratory Duplicate
LR	Laboratory replicate.
MB	Method blank.
MB1	Method Blank 1
MB2	Method Blank 2
MS	Lab Matrix spike.
MS1	Lab Matrix spike 1
MS2	Lab Matrix spike 2
MSD	Lab Matrix spike duplicate.
MSD1	Lab Matrix spike duplicate 1
MSD2	Lab Matrix spike duplicate 2
REG	Regular environmental field sample.
RM1	Reference material (LCS) 1
RM2	Reference material (LCS) 2
SMQC	Source material quality control
UNK	Unknown (for historical data only)

Result Type	
Value	**Description**
0	Original Run
DL1	Dilution 1
DL2	Dilution 2
DL3	Dilution 3
DL4	Dilution 4
DL5	Dilution 5
E1	Extraction 1
E2	Extraction 2
E3	Extraction 3
E4	Extraction 4
RA0	Reanalysis
RA1	Reanalysis 1
RA2	Reanalysis 2
RA3	Reanalysis 3
RA4	Reanalysis 4
RA5	Reanalysis 5

SNEDD LAB VALID VALUES

QC Control Limit Code	
Value	**Description**
CLPA	CLP accuracy limits for spiked samples
CLPCC	CLP continuing calibration acceptance criteria
CLPIC	CLP initial calibration acceptance criteria
CLPLR	CLP precision for lab replicates
CLPP	CLP precision limits for spiked samples
DU	Data unavailable
LCC	Laboratory continuing calibration accuracy
LIC	Laboratory initial calibration accuracy
LLR	Laboratory established precision for lab replicates
LSA	Laboratory sample accuracy for spiked samples
LSP	Laboratory sample precision for spiked samples
MEA	Method established accuracy for spiked samples
MECC	Method established continuing calibration acceptance criteria
MEIC	Method established initial calibration acceptance criteria
MELR	Method established precision for laboratory replicates
MEP	Method established precision for spiked samples
MLR	Matrix laboratory relicate precision
MSA	Matrix spike accuracy for spiked samples
MSP	Matrix spike precision for spiked samples
SBSA	Both reagent and matrix sample accuracy for surrogates
SBSP	Both reagent and matrix sample precision for surrogates
SCLA	CLP limits for accuracy for surrogates
SCLP	CLP limits for surrogate precision
SLSA	Laboratory sample limits for accuracy for surrogates
SLSP	Laboratory sample limits for precision for surrogates
SMEA	Method established limits for accuracy for surrogates
SMEP	Method established limits for precision for surrogates
SMSA	Sample matrix limits for accuracy for surrogates
SMSP	Sample matrix limits for precision for surrogates
SRAD	Standard reference accuracy defined by agency/manufacturer
SRMA	Standard reference material accuracy limits determined by lab
SRMP	Standard reference material precision limits
SRPD	Standard reference precision defined by agency/manufacturer

GC Column Type	
Value	**Description**
1C	First column result - The value obtained from the first column
2C	Second column result - The value obtained from the second column
MS	GC/MS result - Value confirmed using GC/MS
NR	Not reported - Data not reported
NU	Not usable - Data not usable
PR	Primary result - The primary result for a parameter

Lab Qualifier	
Value	**Description**
* (metals)	Lab duplicate analysis was not within control limits
+ (metals)	Correlation coefficient <0.995
B (all others)	Possible blank contamination
B (metals)	Below detection limit
C (all)	Laboratory comment
D (all)	Diluted result
E (metals)	Estimated concentration due to interference
E (all others)	Concentration has exceeded the calibration range
H (all)	Missed holding times
J (organic)	Below detection limit
M (metals)	Duplicate injection precision was not met
N (metals)	Spiked sample recovery was not within control limits
P (pest/p)	Difference between the concentration on the two columns is greater than 20%
S (metals)	Concentration determined by Method of Standard Additions (optional)
U (all)	Not detected above the detection limit
W (metals)	Post-digestion spike outside limits and sample absorbance <50% spike absorbance

Sample Medium	
Value	**Description**
A	Air
L	Nonaqueous Liquid
M	Multi-phase
S	Soil
SOLID	Solid - not soil
T	Tissue
TCLP	Toxicity characteristic leachate procedure
UNK	Unknown
W	Water

QC Level	
Value	**Description**
1	Level 1
2	Level 2
3	Level 3
4	Level 4
A	Level A
B	Level B
C	Level C
D	Level D
NV	Not validated
UNK	Unknown

SNEDD VALIDATION VALID VALUES

QC Narrative (EnDat Data Validation Qualifier Codes)	
Value	**Description**
TN	Tune
BSL	Blank Spike/LCS – Low Recovery
BSH	Blank Spike/LCS – High Recovery
BD	Blank Spike/Blank Spike Duplicate(LCS/LCSD) Precision
BRL	Below Reporting Limit
EMPC	Estimated Possible Maximum Concentration
ISL	Internal Standard – Low Recovery
ISH	Internal Standard – High Recovery
MSL	Matrix Spike and/or Matrix Spike Duplicate – Low Recovery
MSH	Matrix Spike and/or Matrix Spike Duplicate – High Recovery
MI	Matrix interference obscuring the raw data
MDP	Matrix Spike/Matrix Spike Duplicate Precision
2S	Second Source – Bad reproducibility between tandem detectors
SSL	Spiked Surrogate – Low Recovery
SSH	Spiked Surrogate – High Recovery
SD	Serial Dilution Reproducibility
ICL	Initial Calibration – Low Relative Response Factors
ICH	Initial Calibration – High Relative Response Factors
ICB	Initial Calibration – Bad Linearity or Curve Function
CCL	Continuing Calibration Verification – Low Recovery
CCH	Continuing Calibration Verification – High Recovery
CC	Continuing Calibration
LD	Lab Duplicate Reproducibility
HT	Holding Time
PD	Pesticide Degradation
2C	Second Column – Poor Dual Column Reproducibility
LR	Concentration Exceeds Linear Range
BL	Blank Contamination - MBL, EBL, FBL, TBL
RE	Redundant Result - due to Reanalysis or Re-extraction
DL	Redundant Result – due to Dilution
FD	Field Duplicate
OT	Other

Validator Qualifier	
Value	**Description**
U	Not Detected
	Confirmed Identification
B	Not detected substantially above the level reported in laboratory or field blanks
R	Unreliable result
N	Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
J	Analyte present. Reported value may or may not be accurate or precise
J+	Analyte present. Reported value may be biased high. Actual value is expected to be lower
J-	Analyte present. Reported value may be biased low. Actual value is expected to be higher
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher
UJ	Not detected, quantitation limit may be inaccurate or imprecise
UL	Not detected, quantitation limit is probably higher
Q	Estimated dioxin/furan concentration
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity
I	Interferences present which may cause the results to be biased higl
X	Dioxins only: Estimated Maximum Possible Concentration

SNEDD UNITS LOOKUP TABLE

Units	
Value	**Description**
ACR	Acres - 43,560 sq. feet
ATM	Atmospheres
BTU	British thermal units
CC	cubic centimeter
CFU_100ML	Colony forming units per 100 mL
CFU_10G	Colony forming units per 10g
CFU_G	Colony forming units per gram
CFU_L	Colony forming units per liter
CFU_ML	Colony-forming units per milliliter
CM	Centimeters
CM_SEC	Centimeters per second
CM2_SEC	Centimeters squared per second
COLOR_UNITS	Color units
COUNT	Count
COUNT_G	Count per gram
COUNT_MG	Count per milligram
D	Day, approximately 24 hours
DEG	Degrees
DEG_C	Degrees centigrade
DEG_F	Degrees Fahrenheit
FIBER_KG	Asbestos short fibers counted per kilogram
FIBER_L	Asbestos short fibers counted per liter
FT	Feet
FT_DAY	Feet per day
FT_FT	Feet per feet
FT_MILE	Feet per mile
FT_SEC	Feet per second
FT2	Feet squared
FT2_D	Feet squared per day
FT3	Feet cubed
FT3_D	Hectares - 2.471044 acres
FT3_MIN	Cubic feet per minute
FT3_SEC	Cubic feet per second
G	Gram
G_CC	Grams per cubic centimeter
G_KG	Grams per kilogram
G_L	Grams per liter
G_ML	Grams per milliliter
GAL	A unit of capacity or volume used in liquid measure equal to 4 quarts or 3.785 liters
GAL_D	Gallons per day
GAL_MIN	Gallons per minute
GAL_SEC	Gallons per second
GC_L	Gene Copies per liter
HA	Hectares - 2.471044 acres
IN	Inches
IN_H2O	Inches per water (pressure)
IN_HG	Inches per mercury (pressure)
IND	Individuals
IONBAL	Ion balance
KDA	Kilodalton
KG_M3	A density equal to one thousand grams in a cubic meter
L	Liters
L_D	Liters per day
L_MIN	Liters per minute
L_SEC	Liters per second
LB_FT_FT2	Pound feet per square foot
LB_FT_FT3	Pound feet per cubic foot
LB_FT3	Pounds per feet cubed
LIQLIM	Liquid limit
M	Meters
M_DAY	Meters per day

SNEDD UNITS LOOKUP TABLE

Units	
Value	**Description**
M_SEC	Meters per second
M2	Meters squared
M3_D	Meters cubed per day
M3_MIN	Meters cubed per minute
M3_SEC	Meters cubed per second
MEQ_100G	Milliequivalents per 100 grams
MEQ_G	Milliequivalents per gram
MEQ_L	Milliequivalents per liter
MFIBER_L	Million Fibers per Liter
MG	Milligrams
MG_BOTTLE	Milligrams per bottle
MG_CM2	Milligrams per square centimeter
MG_CM3	Milligrams per cubic centimeter
MG_D	Milligrams per day
MG_KG	Milligrams per kilogram
MG_KG_WETWT	Milligrams per kilogram wet weight
MG_KGOC	Milligrams per kilogram Normalized to TOC
MG_L	Milligrams per liter
MG_LCACO3	Milligrams per liter as $CaCO_3$
MG_M3	Milligrams per cubic meter
MG_ML	Milligrams per milliliter
MG_ORG	Milligrams per Organism
MG_WIPE	Milligrams per wipe
MGAL_D	Million gallons per day
mgO2/L	Milligrams of oxygen per liter
MILE	Mile
MILLIDARCY	Millidarcy
MIN	Minutes
ML	Milliliters
ML_L	Milliliter per liter
MM	Millimeters
MM_Y	Millimeters per year
MMHOS_CM	Milli mho
MPN_100G	Most probable number per 100 grams
MPN_100ML	Most probable number per 100 ml
MPN_G	Most probable number per gram
MPN_ML	Most probable number per milliliter
MS_CM	Milliseimens per centimeter
MS_L	Milliseimens per liter
MS_M	Millisiemens per meter
MSL	Mean Sea Level
MV	Millivolts
NA	Not applicable
NG	Nanograms
NG_100CM2	Nanograms per 100 square centimeters
NG_G	Nanograms per gram
NG_G_WETWT	Nanograms per gram wet weight
NG_KG	Nanograms per kilogram
NG_L	Nanograms per liter
NG_ML	Nano-grams per milliliter
NG_SAMPLE	Nanogram per sample
NG_TRAP	Nanogram/air trap
NI	Non-ignitable
NMOLES	Nanomoles
NMOLES_G	Nanomoles per gram
NONE	None
NTU	Nephelometric turbidity unit
OZ	Ounce
PARTICLES	Particles
PCI	Picocurie
PCI_G	Picocurie/gram

SNEDD UNITS LOOKUP TABLE

Units	
Value	**Description**
PCI_L	Picocurie/liter
PCI_ML	picocuries/mL
PCT	Percent
PCT_CACO3	Percent as $CaCO_3$
PCT_DIFF	Percent difference
PCT_MST	Percent moisture
PCT_REC	Percent recovery
PCT_SAT	Percent saturated
PCT_SLD	Percent SLD
PCT_V	Percent Volume
PG_G	Picograms per gram
PG_G_WETWT	Picograms per gram wet weight
PG_L	Picograms per liter
PG_S	Picograms per sample
PG_UL	Picograms per microliter
PH	pH units
PLASIND	Plasticity index
PLASLIM	Plasticiy limit
POROSITY	Porosity
PPB	Parts per billion
PPBV	Parts per billion volume
PPM	Parts per million
PPMV	Parts per million mass volume
PPQ	Parts per quadrillion
PPT	Parts per trillion
PPTH	Parts per thousand
PSU	Practical salinity units
RATIO	Ratio
SALIN	Salinity
SPC_ML	Species per milliliter
SPGRVTY	Specific gravity
STRUCTURES_CC	Structures per cubic centimeter
SU	Standard units
TCACO3_KT	Tons $CaCO_3$ per 1000 tons material
TONU	Threshold odor number unit
TOTAL_UG	Total Micrograms
TRN	Total radioactive nuclide
UEQ_G	Micro-equivalents per gram
UG	Micrograms
UG_100CM2	Micrograms per 100 square centimeters
UG_CM2	Micrograms per square centimeter
UG_FILTER	Micrograms per filter
UG_FT2	Micrograms per square foot
UG_G	Micrograms per gram
UG_KG	Micrograms per kilogram
UG_KG_WETWT	Micrograms per kilogram wet weight
UG_L	Micrograms per liter
UG_M3	Micrograms per cubic meter
UG_ML	Micrograms per milliliter
UG_TUBE	Micrograms per tube
UG_WIPE	Micrograms per wipe
UMHO_CM	Micromhos per centimeter
UMHOS	Micro mho
UMOL_G	Micromoles per gram
UNKNOWN	Unknown units
UORG_ML	Microorganisms per milliliter
US_CM	Microseimens per centimeter
YD	Yard

Using the EnStat Tool

by Lane Ebert/WDC
Updated by Chelsea Bennet
9/26/07

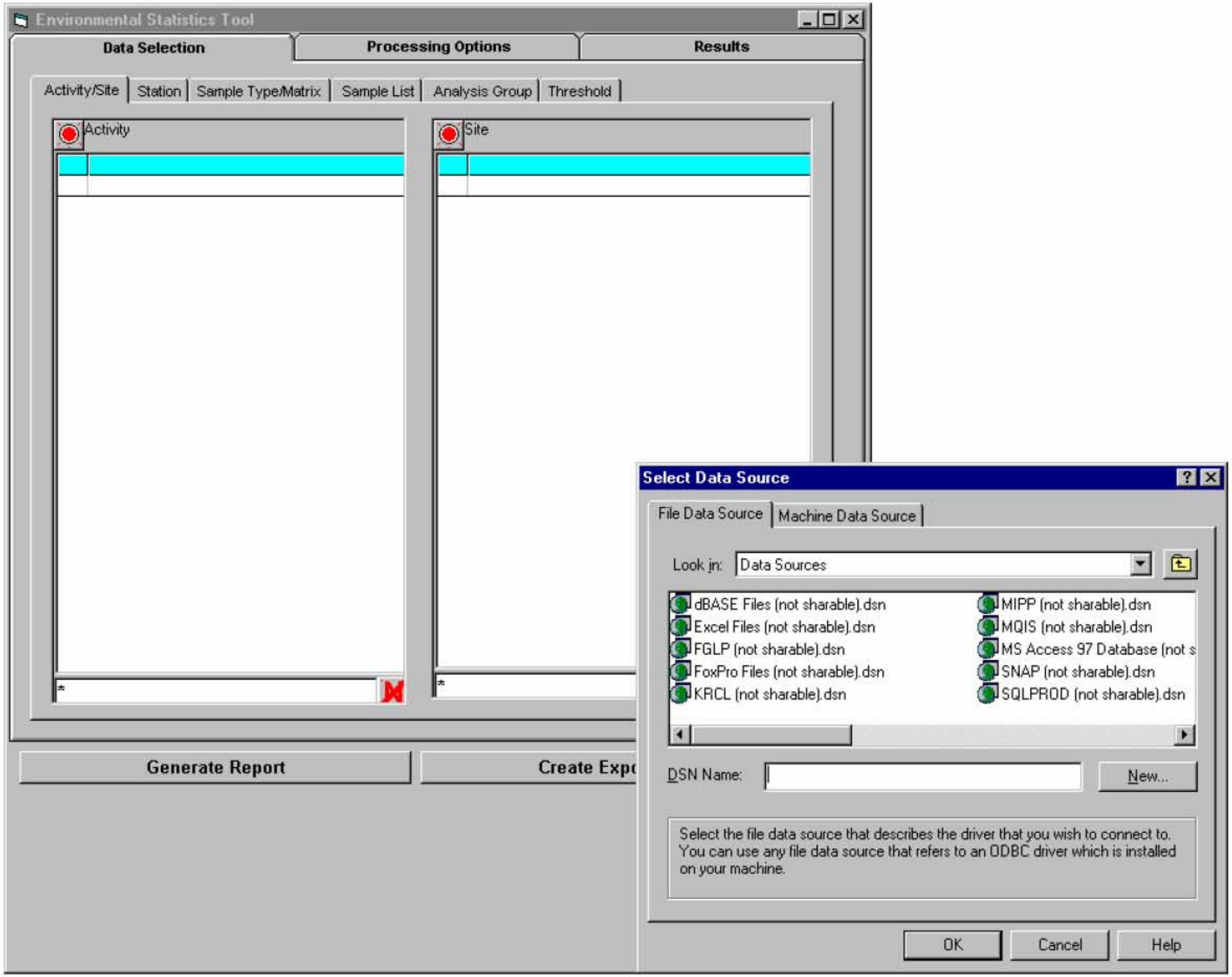
INSTALLING ENSTAT:

EnStat is accessed through a Citrix connection. Following the instructions “EnStat Login Through Citrix” to gain access.

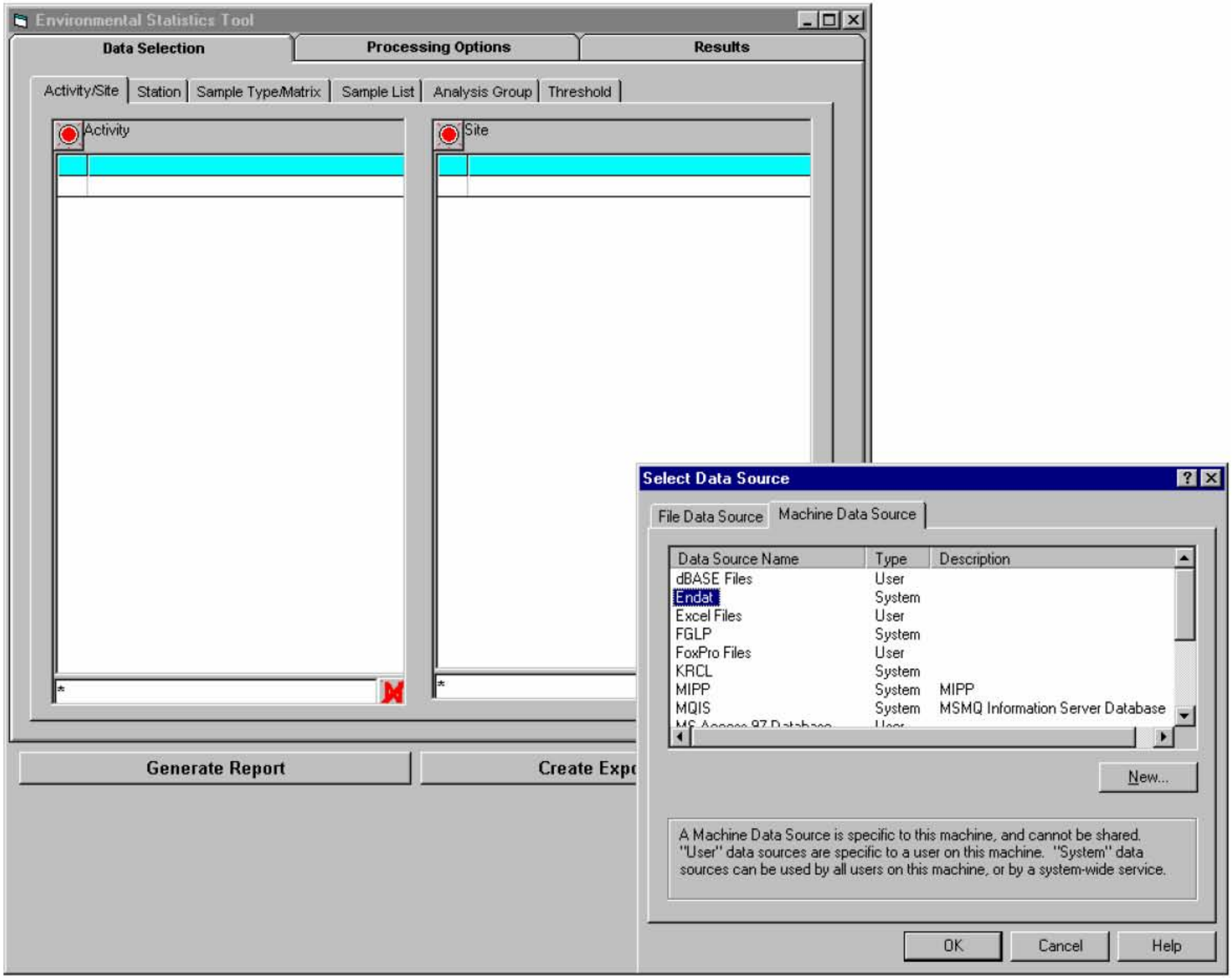
GUIDANCE ON PERFORMING AN ENSTAT QUERY:

The slides that follow detail the steps in performing an EnStat query.

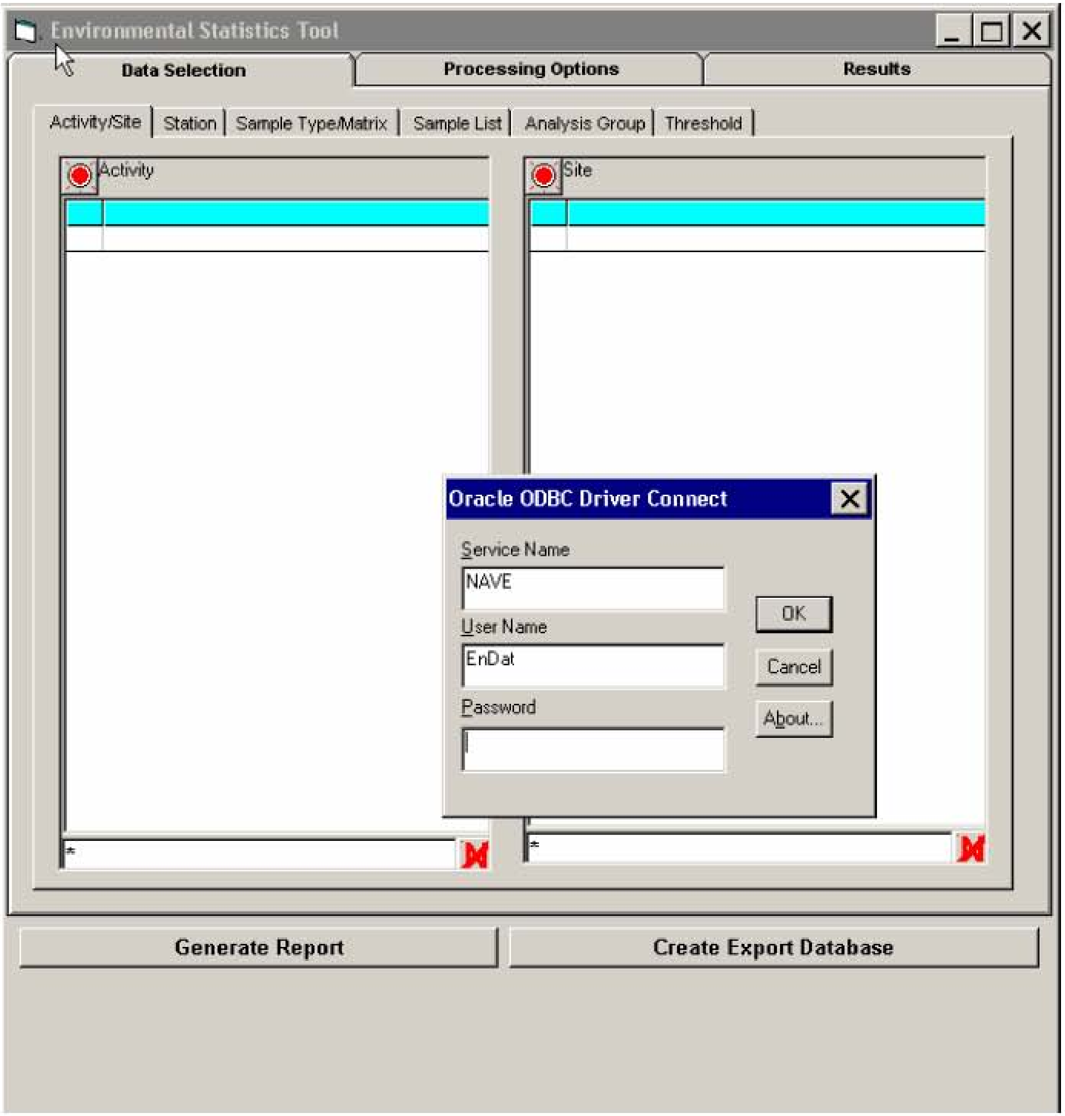
1) When you first open the Environmental Statistics Tool (EnStat) the two windows below appear on your desktop.



2) Select the Machine Data Source Tab and then Endat from the list of Data Source Names. Hit OK.



3) A new window appears to connect you to Oracle. Enter “endat” for the User Name and Password. The Service name should be NAVE. Hit OK.

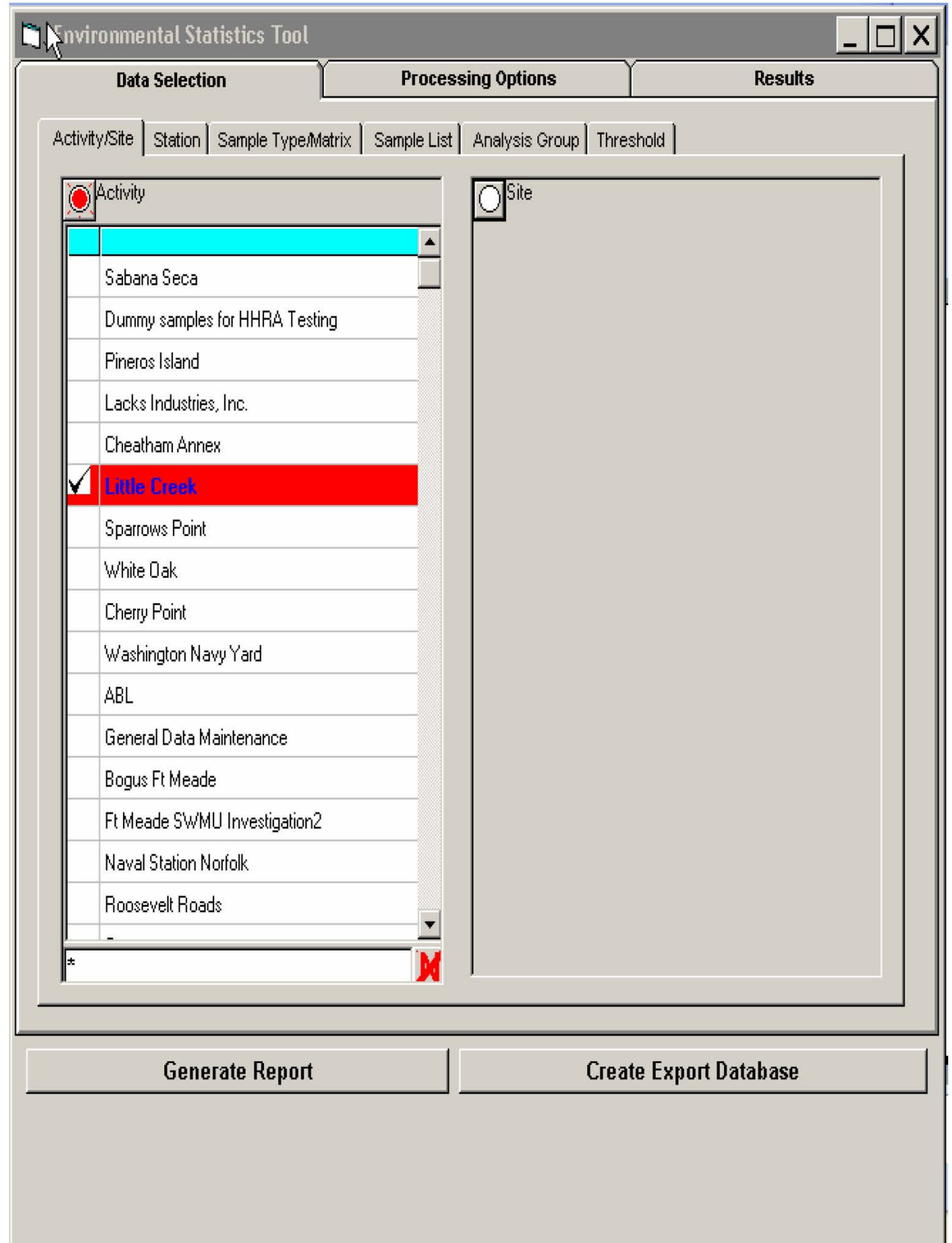


4) EnStat opens to the Data Selection tab and the Activity/Site subtab. Select the Activity(s) you would like to query in this run.

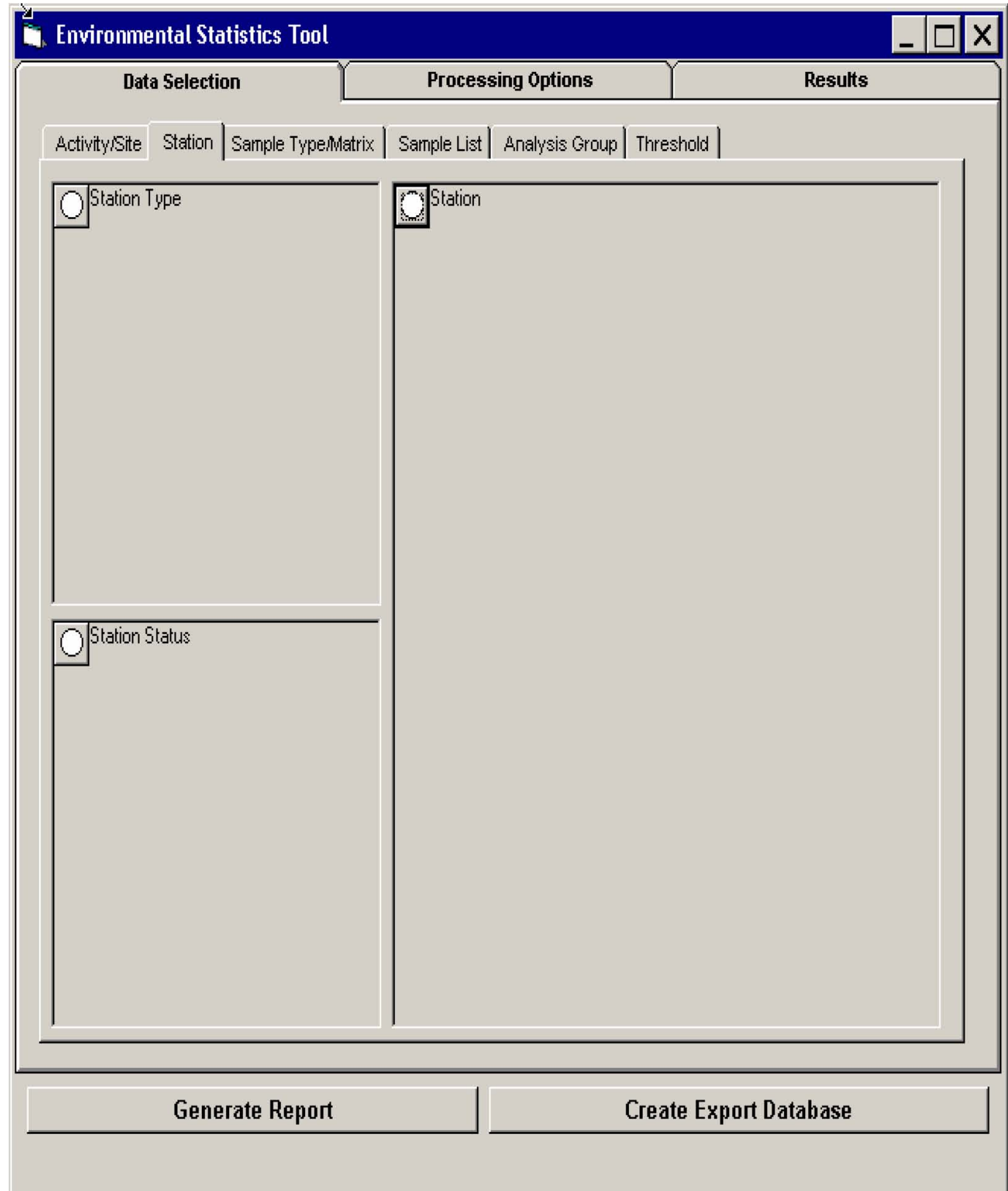
Do not select a Site. Select the  button in the upper left corner of the Site table. This table is now grayed out. When finished, select the Station subtab.

Note: you must know something about how the data you're querying are stored in EnDat to select values in EnStat correctly. If you have questions on sample naming convention was used for this facility then ask an EIS or database manager.

Note: you must select each option individually. Shift and Ctrl functions do not work in this environment.



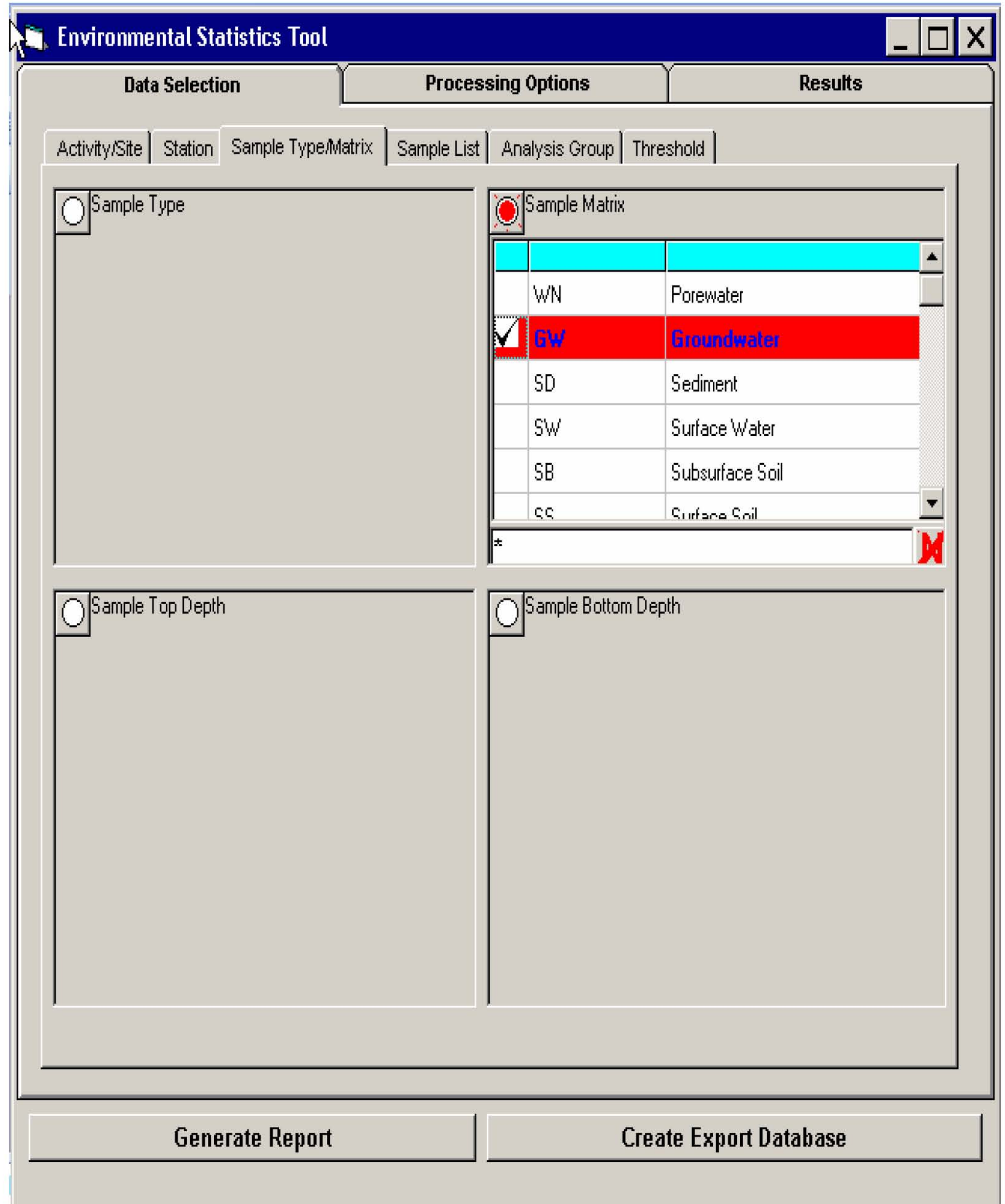
5) The Station subtab has three tables: Station Type, Station Status, and Station. Select the  button in the upper left corner of each table. This table is now grayed out.



6) The Sample Type/Matrix subtab has four tables: Sample Type, Sample Matrix, Sample Top Depth, and Sample Bottom Depth. **Do Not select the Sample Type(s), Sample Top Depth(s), or Sample Bottom Depth(s).** Instead, select the  button in the upper left corner of the tables. These tables are now grayed out.

Click on the Sample Matrix Desired. This row will be highlighted in Red. Note – only one matrix should be selected, as tables must be pulled by Site and matrix.

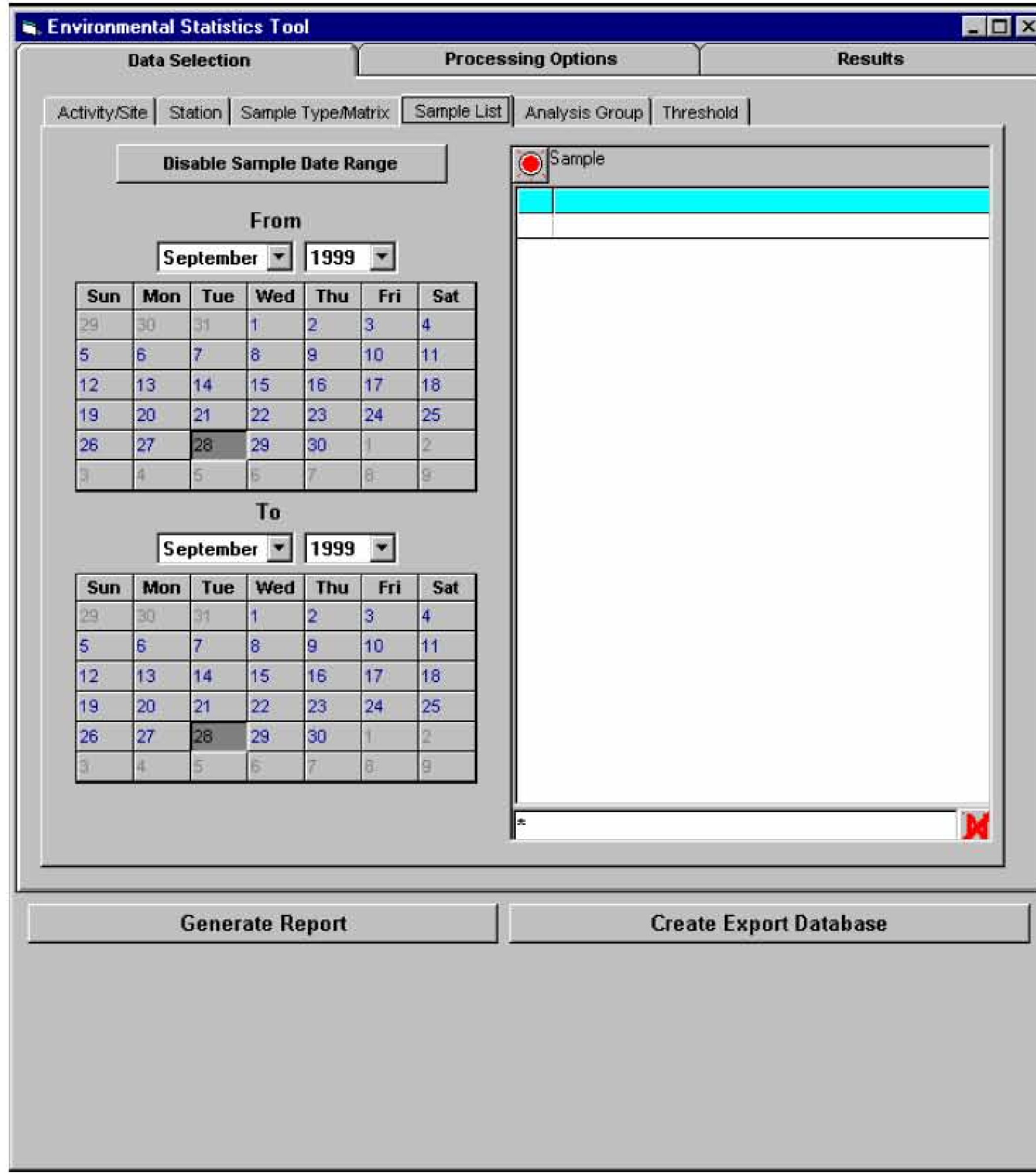
When finished, select the Sample List subtab.



7) The Sample List subtab has one table named Sample, two calendars, and a button entitled “Disable Sample Date Range”.

A) **Press the “Disable Sample Date Range”** button and ALL samples associated to the Stations you selected and are also of the Sample Type and Sample Matrix you selected will appear.

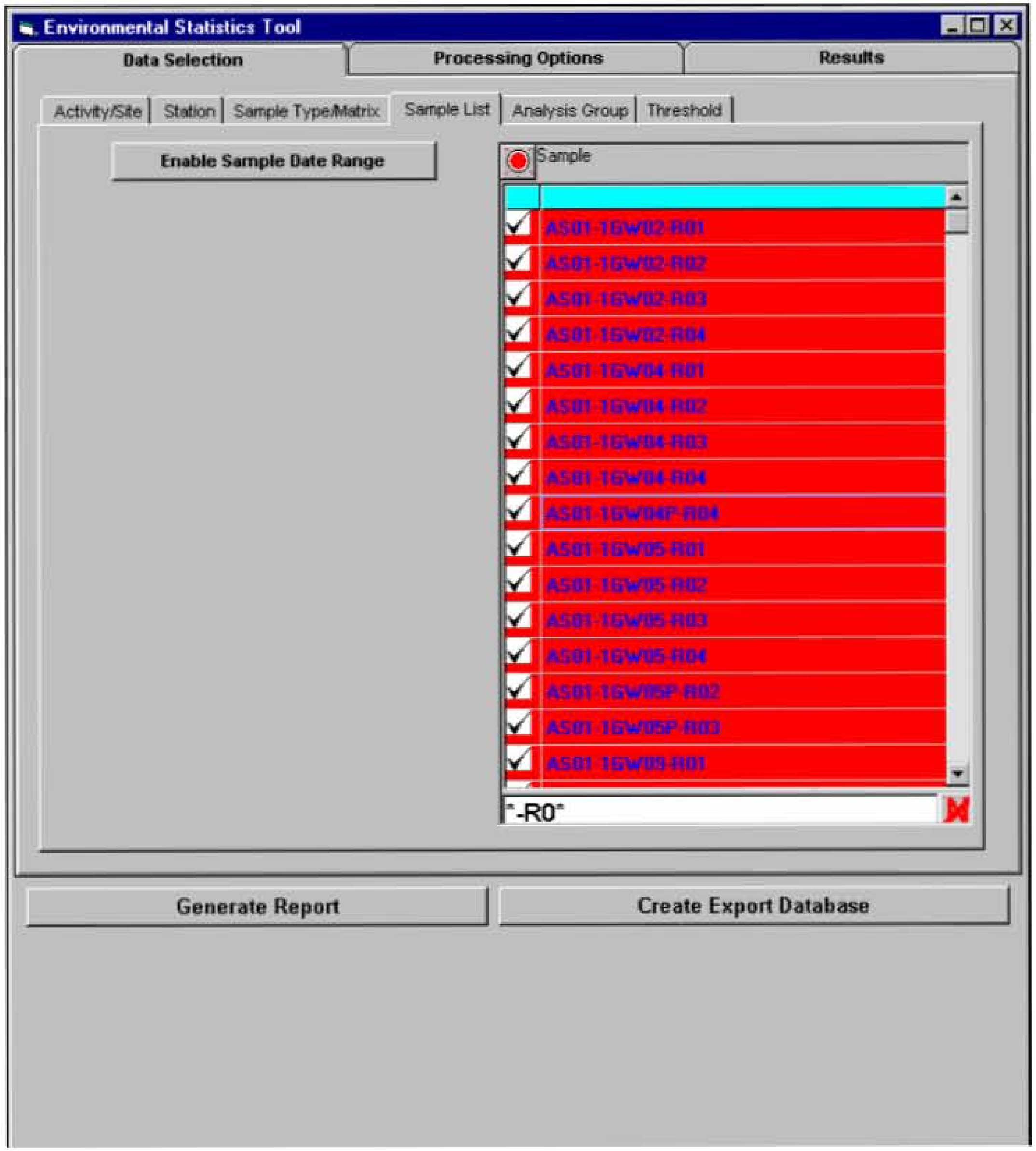
B) Specify search criteria to the query by typing part/all of the sample name in the field next to the no null symbol in the Sample table (i.e. *R01). Click on the  button.



8) Select all the samples you would like to include in your query. When finished, select the Analysis Group subtab.

Note: Please only select samples associated with one medium per query (i.e. solid, aqueous, air). You can not mix mediums since solid and aqueous units are not convertible.

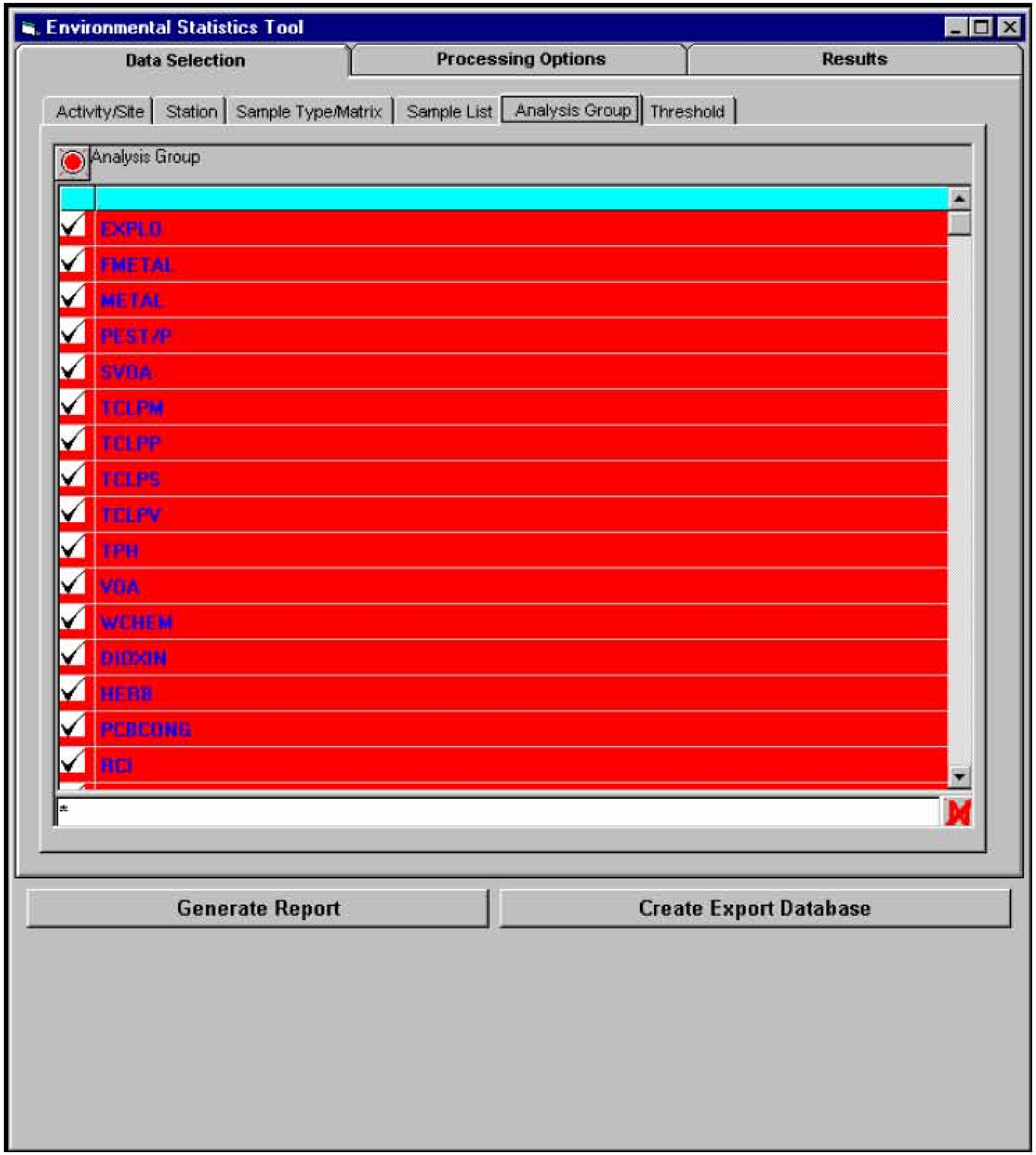
Note: The samples that appear in the Sample table are not sorted in any particular order. To sort them alphabetically, click on the blue bar above the sample IDs.



9) The Analysis Group subtab contains one table named Analysis Group. Select All the analysis groups you would like to include in your query.

If you would like to include all the analysis groups the samples were analyzed for then right click in the Analysis Group table and select "Select All" from the menu window. It does not cause a problem if analysis groups are selected that the samples were not analyzed for.

When finished, select the Threshold subtab.

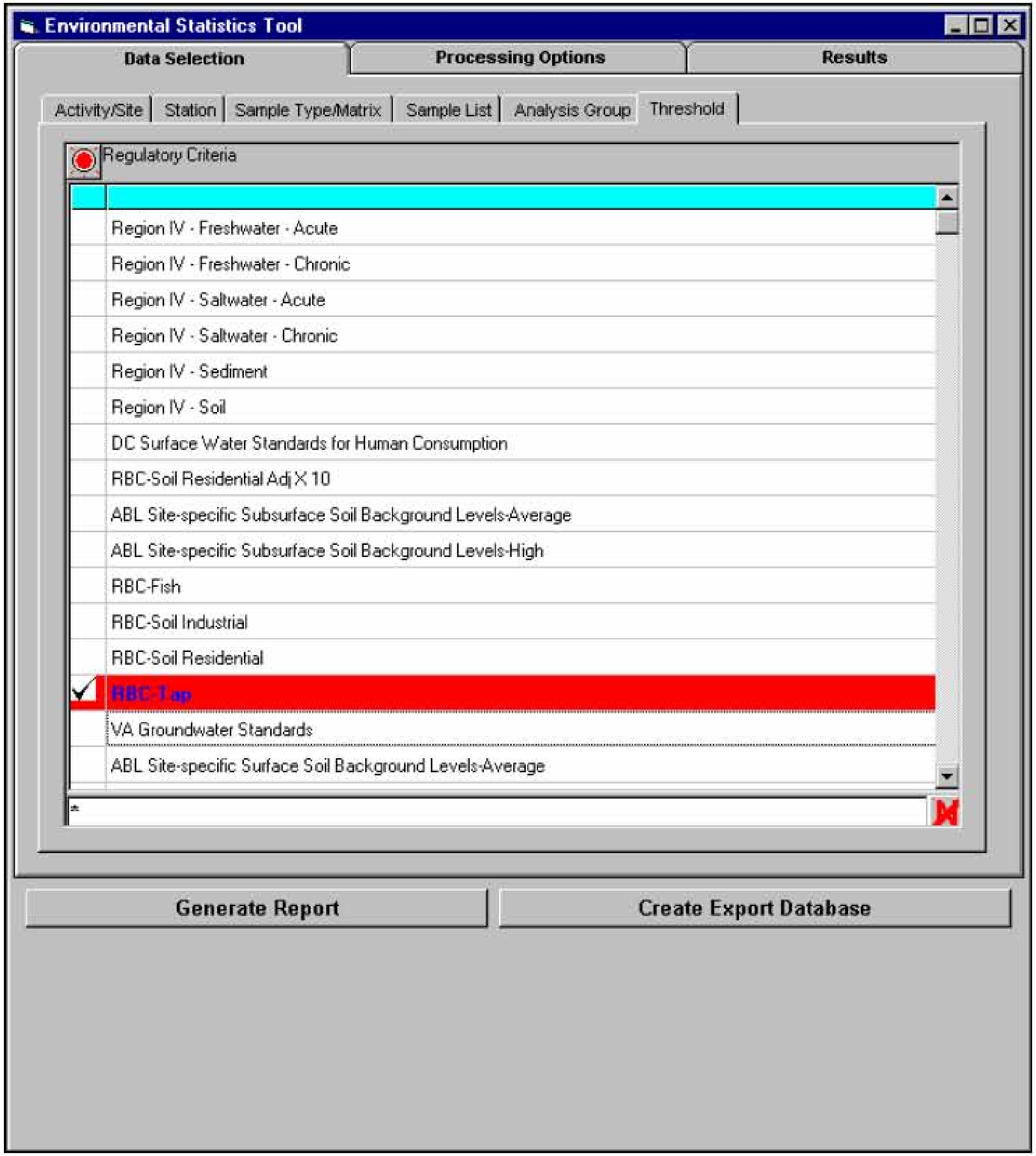


10) The Threshold subtab contains one table named Regulatory Criteria. All of the regulatory criteria currently in EnDat are listed in this table.

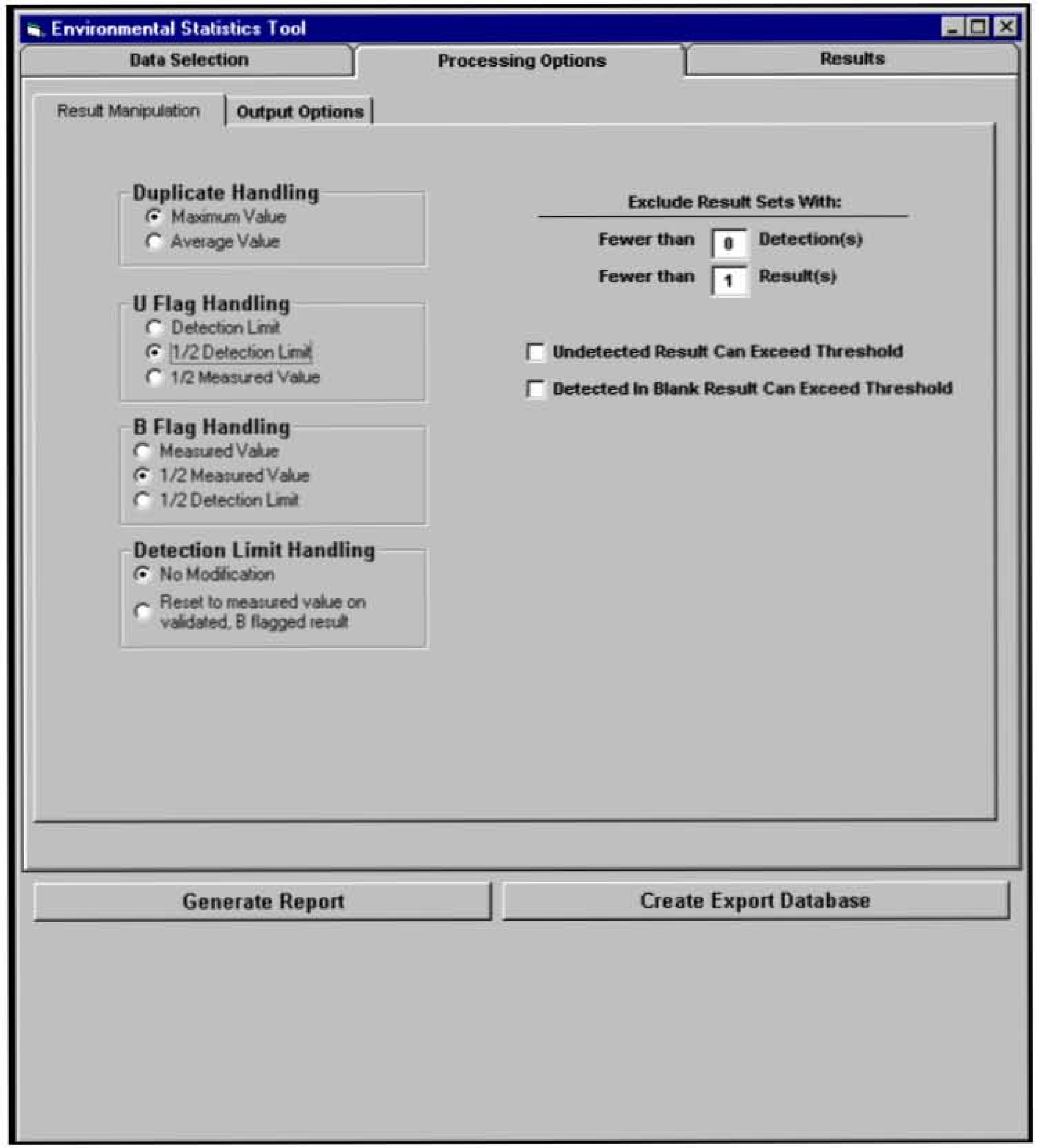
Select one or more criteria from this list that are appropriate for your medium if you would like to create an exceedance table. If you are not creating an exceedance table, then it is not necessary to select any criteria.

If you would like definitions or additional information on any of these regulatory criteria then please contact Mike Zamboni/WDC.

When finished, select the Processing Options tab.



11) The Processing Options tab opens to the Result Manipulation subtab. The Result Manipulation subtab contains options to exclude result sets based on the number of detections and/or results; options to enable undetected results and/or detected in blank results to exceed thresholds; four sets of option buttons for duplicate handling, U-flag handling, B-flag handling, and detection limit handling in calculating the statistics.



The HHRA folks normally choose the following options in calculating their statistics:

a) maximum value of the duplicates
b) 1/2 detection limit of U-flagged results
c) 1/2 measured value of B-flagged results
d) no modification in detection limits

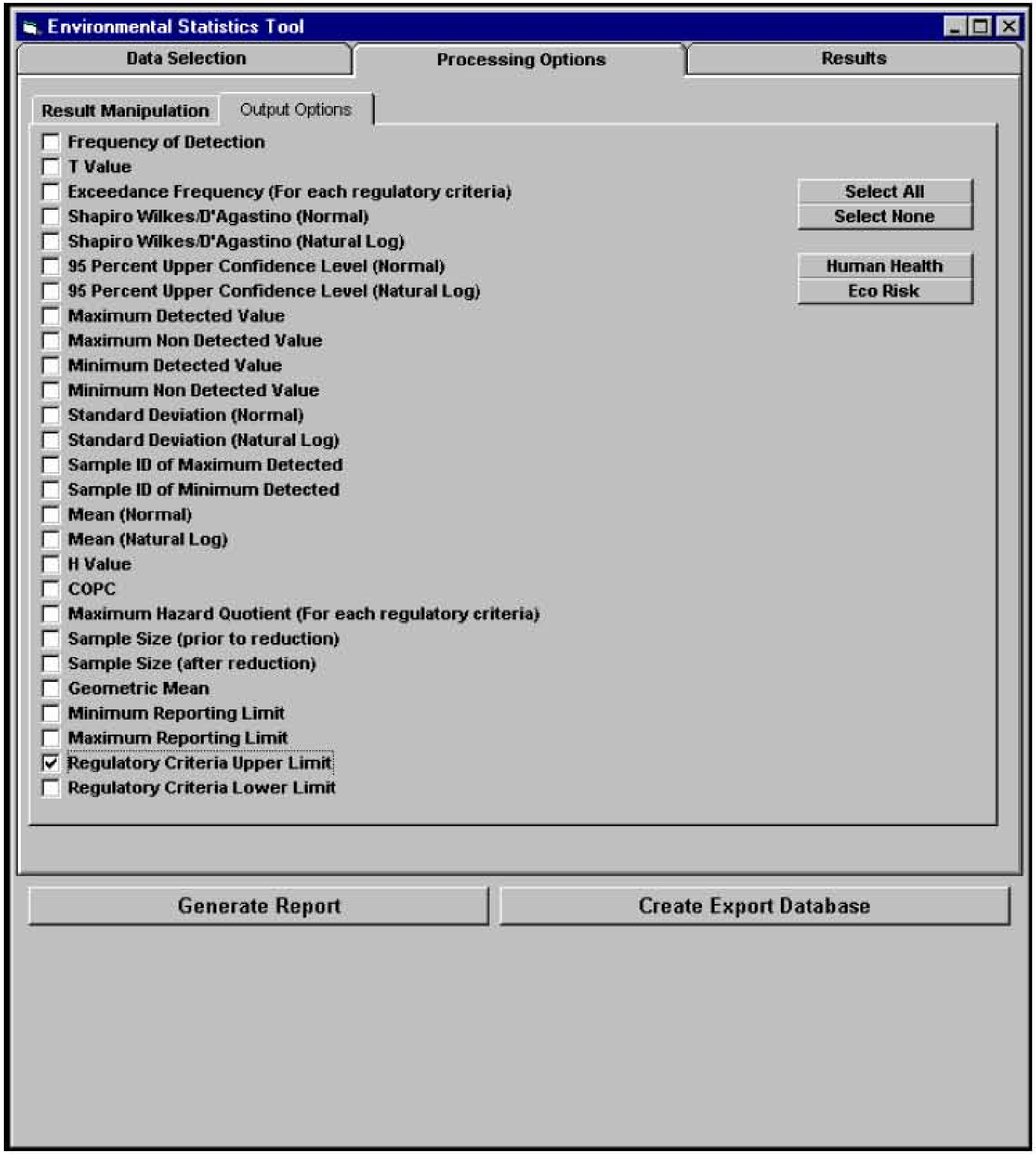
The only variation with the ERA folks is that they normally use the 1/2 measured value for U-flagged results.

When finished, select the Output Options subtab.

12) The Output Options subtab contains option buttons for all the statistics EnStat is capable of calculating. There are four buttons on the right that assist the user in selecting the appropriate statistics.

Click on the button 'Select None'. Then select the check box for 'Regulatory Criteria Upper Limit'.

When finished, select the Results tab.

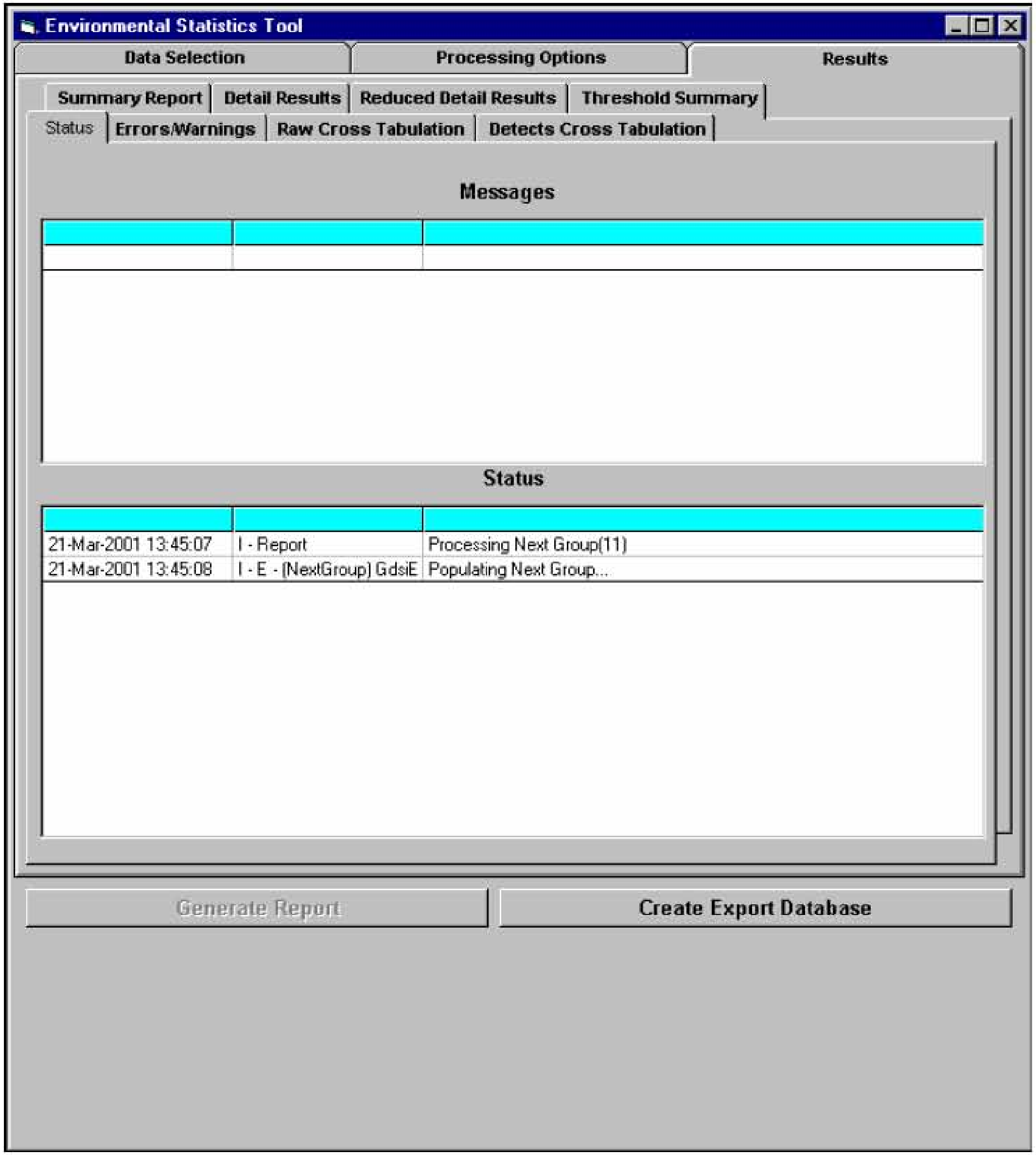


13) The Results tab opens to the Status subtab. Seven other subtabs are contained in the Results tab.

You are now ready to run your query. If you need to make any changes then navigate back to the appropriate subtab to make your change. When ready hit the **“Generate Report”** button at the bottom of the page.

Once the button is pushed, the “Generate Report” button will gray out and the Status window will eventually begin scrolling through the groups. Be patient if the “Processing First Group” statement takes a while to appear.

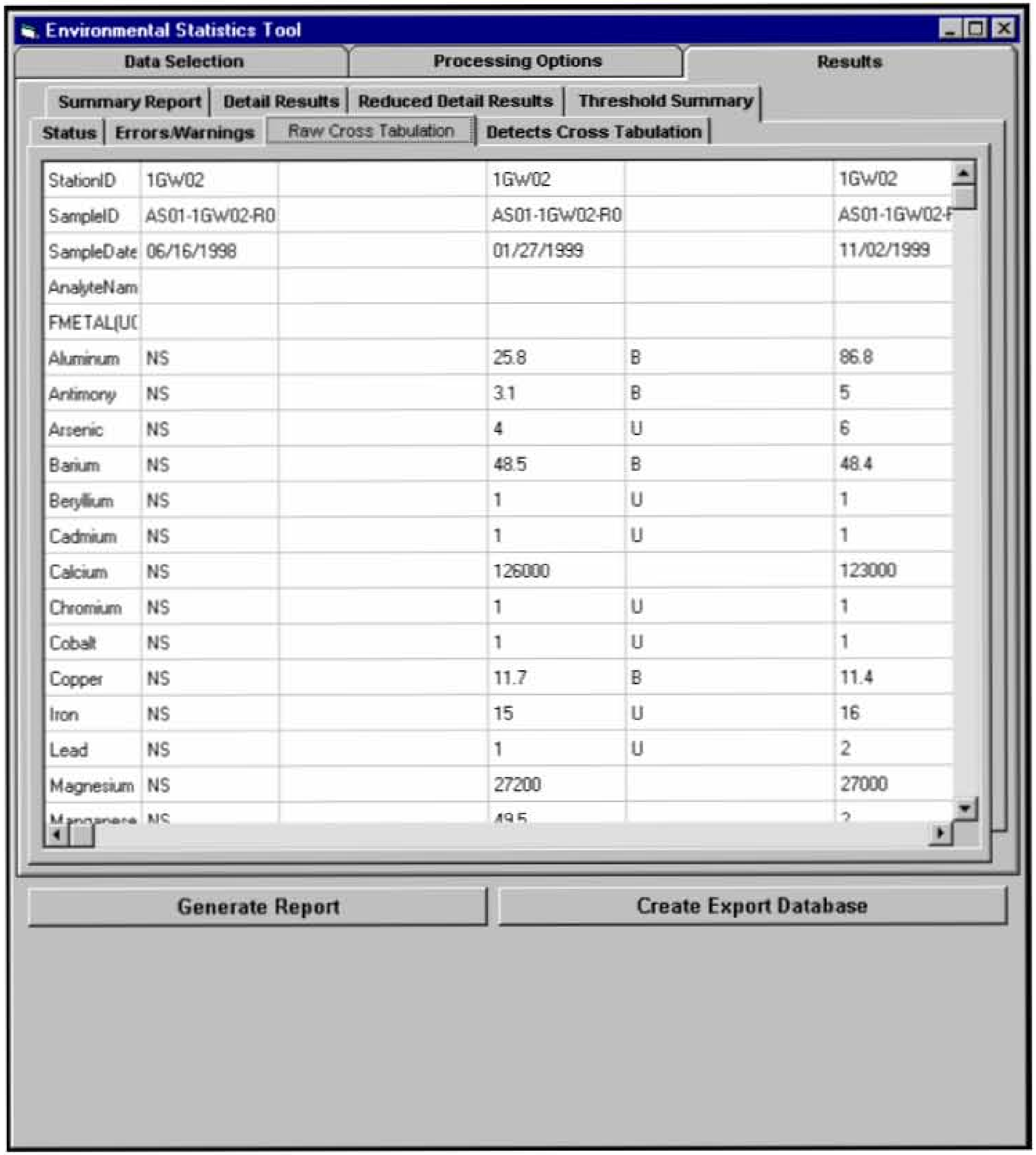
The query is complete when you see the statement “Report is complete” in the Status window.



14) The raw data is contained in the “Raw Cross Tabulation” subtab. To copy this data into Excel, right click in the data window and select “Copy All” from the menu window.

Open the Excel macro for formatting data from EnStat and paste the data into the worksheet “RAW”.

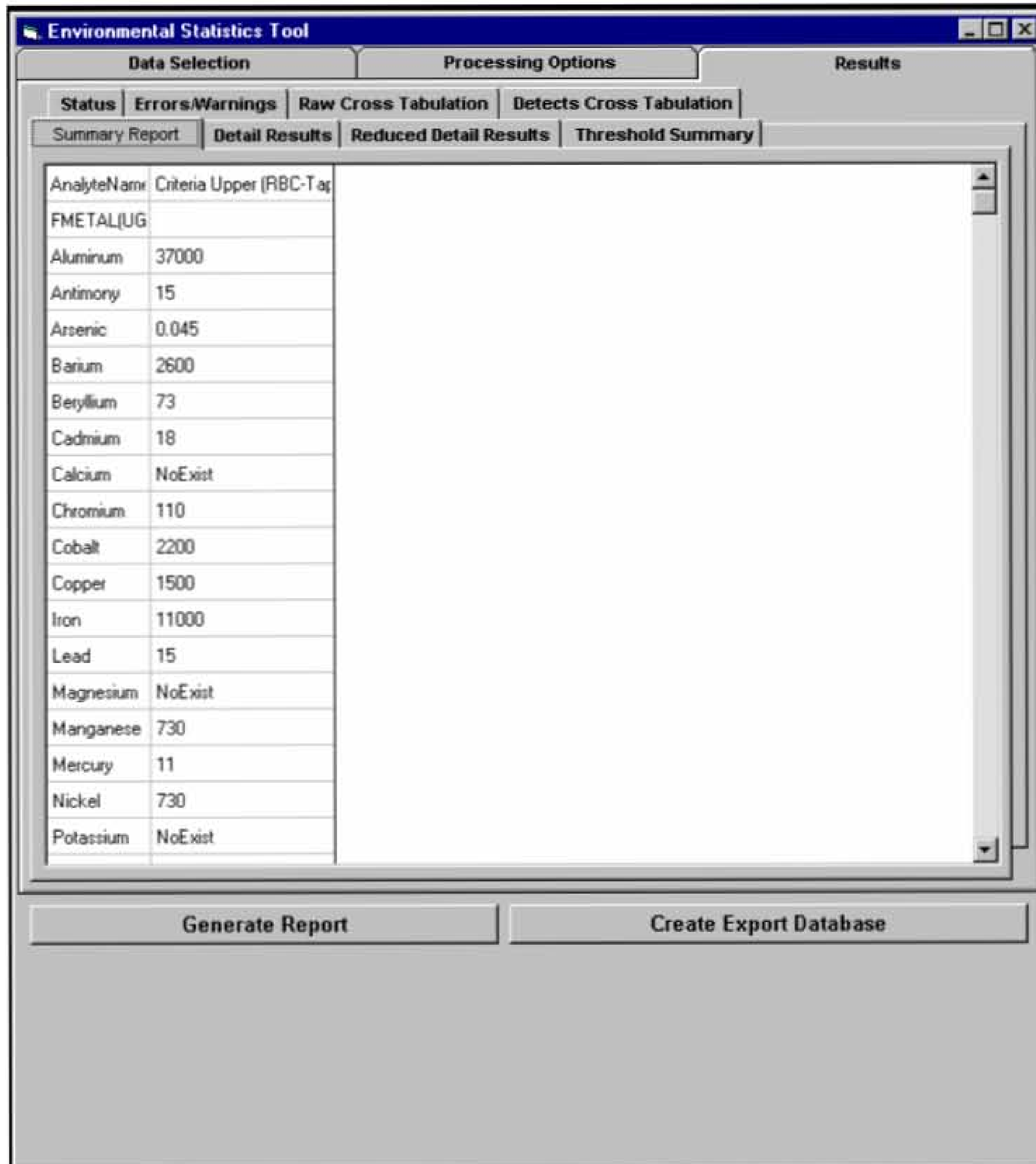
The detected data is contained in the “Detects Cross Tabulation” subtab. Copy this data into the macro worksheet “DETECTS”.



15) The Summary Report subtab contains the results from all the statistics you selected in the Output Options subtab of the Processing Options tab.

In the example to the right, the only statistic that was selected was “Regulatory Criteria Upper Limit”. This statistic option would output the threshold criteria for each of the regulatory criteria selected in the Threshold subtab of the Data Selection tab.

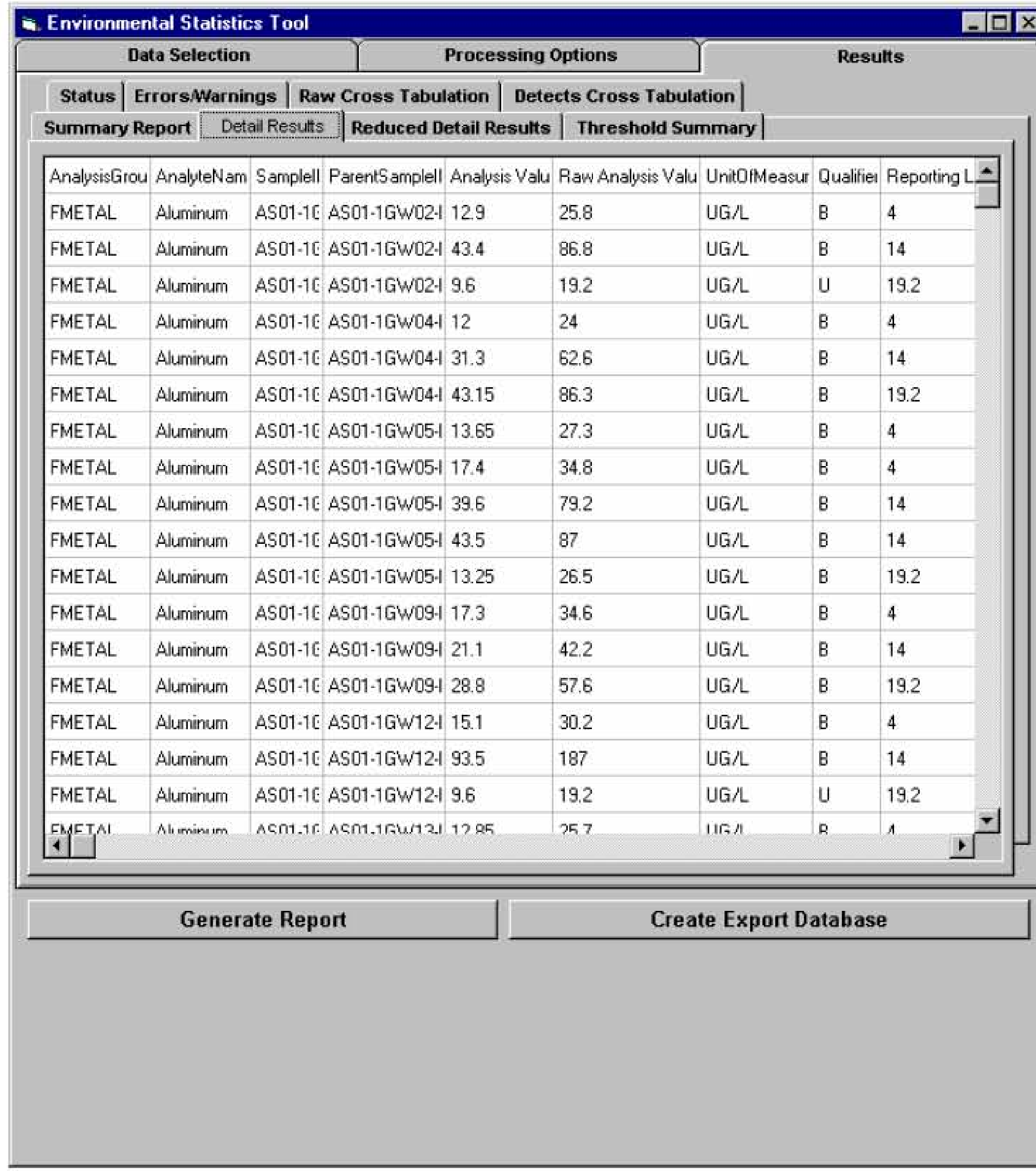
To copy this data into the Excel macro for formatting data from EnStat , right click in the data window and select “Copy All” from the menu window. Open Excel and paste the data into the worksheet tab “STATS”.



16) The Detail Results subtab contains streaming data for each of the data records in the query. The data listed in this subtab include: Analysis Group, Analyte Name, Sample ID, Parent Sample ID, Analysis Value, Raw Analysis Value, Unit of Measure, Qualifiers, and Reporting Limit.

This data on this sheet can be extremely useful in determining the cause of any data errors. For example, if the frequency of detection statistics are wrong then it might turn out to be an error in a duplicate samples' parent sample ID which can be detected by reviewing this data.

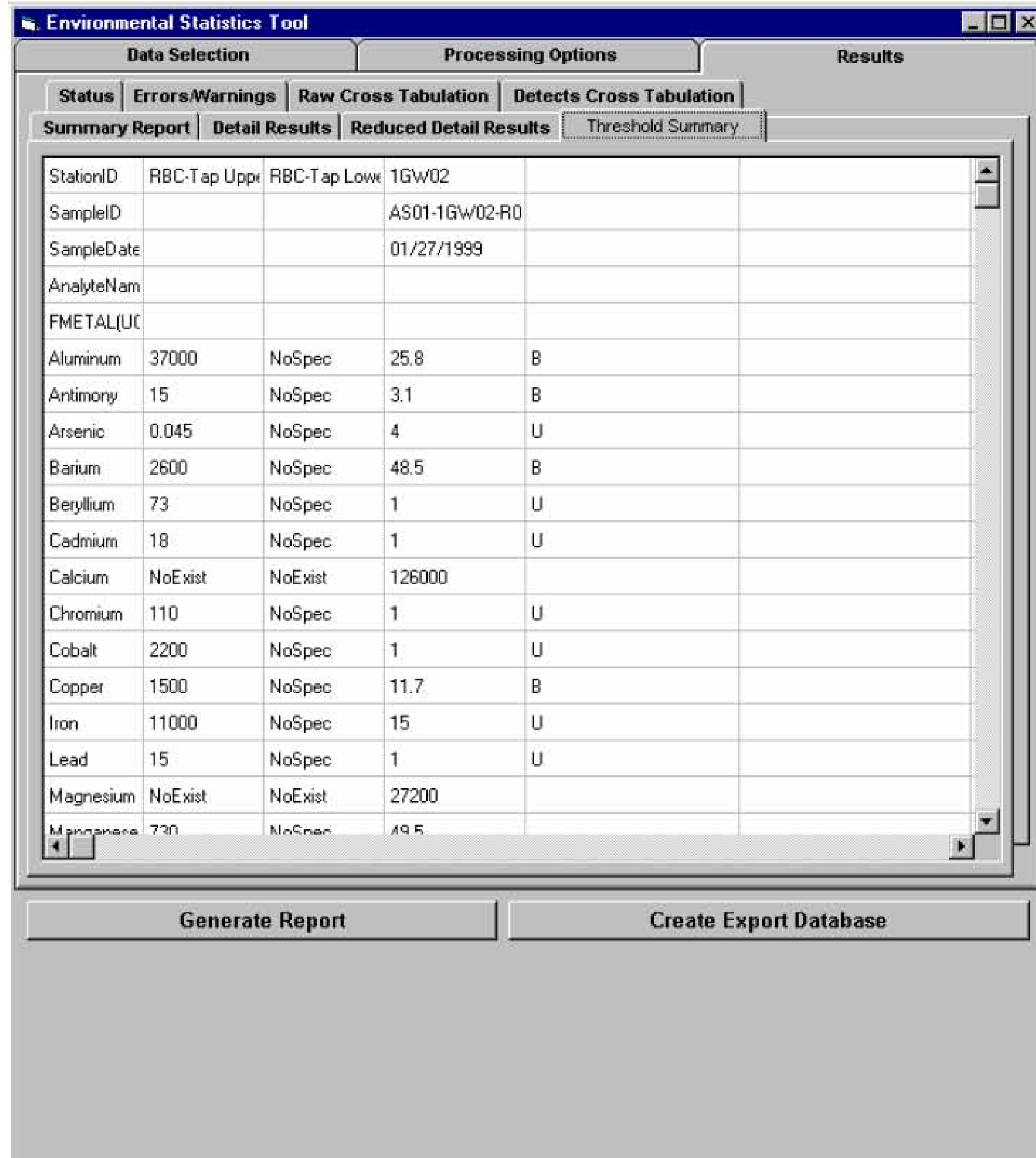
If the qualifier is a U or B then the Analysis Value column contains the value that was calculated according to the handling you specified on the Result Manipulation subtab. The Reporting Limit column contains the detection limit.



AnalysisGrou	AnalyteNam	SampleI	ParentSampleI	Analysis Valu	Raw Analysis Valu	UnitOfMeasur	Qualifie	Reporting L
FMETAL	Aluminum	AS01-1C	AS01-1GW02-I	12.9	25.8	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW02-I	43.4	86.8	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW02-I	9.6	19.2	UG/L	U	19.2
FMETAL	Aluminum	AS01-1C	AS01-1GW04-I	12	24	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW04-I	31.3	62.6	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW04-I	43.15	86.3	UG/L	B	19.2
FMETAL	Aluminum	AS01-1C	AS01-1GW05-I	13.65	27.3	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW05-I	17.4	34.8	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW05-I	39.6	79.2	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW05-I	43.5	87	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW05-I	13.25	26.5	UG/L	B	19.2
FMETAL	Aluminum	AS01-1C	AS01-1GW09-I	17.3	34.6	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW09-I	21.1	42.2	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW09-I	28.8	57.6	UG/L	B	19.2
FMETAL	Aluminum	AS01-1C	AS01-1GW12-I	15.1	30.2	UG/L	B	4
FMETAL	Aluminum	AS01-1C	AS01-1GW12-I	93.5	187	UG/L	B	14
FMETAL	Aluminum	AS01-1C	AS01-1GW12-I	9.6	19.2	UG/L	U	19.2

18) The Threshold Summary subtab compares the Raw data to the regulatory criteria you selected on the Threshold subtab. The upper and lower threshold limits are shown for each regulatory criteria you selected. If the analyte value exceeds the lowest threshold value for that analyte than an “X” is placed in the column to the right of the sample qualifier column.

Note: There is currently no method of formatting the output from this subtab. If you want to create a formatted Exceedance Report than you need to select Regulatory Criteria Upper Limit from the Output Options subtab and run the Exceedance formatting macro in the macro template files. This macro uses the data in EnStat’s “Raw Cross Tabulation” and “Summary Report” subtabs.



StationID	RBC-Tap Uppe	RBC-Tap Lowe	1GW02	
SampleID			AS01-1GW02-R0	
SampleDate			01/27/1999	
AnalyteNam				
FMETAL(UC				
Aluminum	37000	NoSpec	25.8	B
Antimony	15	NoSpec	3.1	B
Arsenic	0.045	NoSpec	4	U
Barium	2600	NoSpec	48.5	B
Beryllium	73	NoSpec	1	U
Cadmium	18	NoSpec	1	U
Calcium	NoExist	NoExist	126000	
Chromium	110	NoSpec	1	U
Cobalt	2200	NoSpec	1	U
Copper	1500	NoSpec	11.7	B
Iron	11000	NoSpec	15	U
Lead	15	NoSpec	1	U
Magnesium	NoExist	NoExist	27200	
Manganese	730	NoSpec	49.5	

19) The Errors/Warnings subtab lists the errors encountered while processing the query, the time of the error, and the error location within the EnStat code.

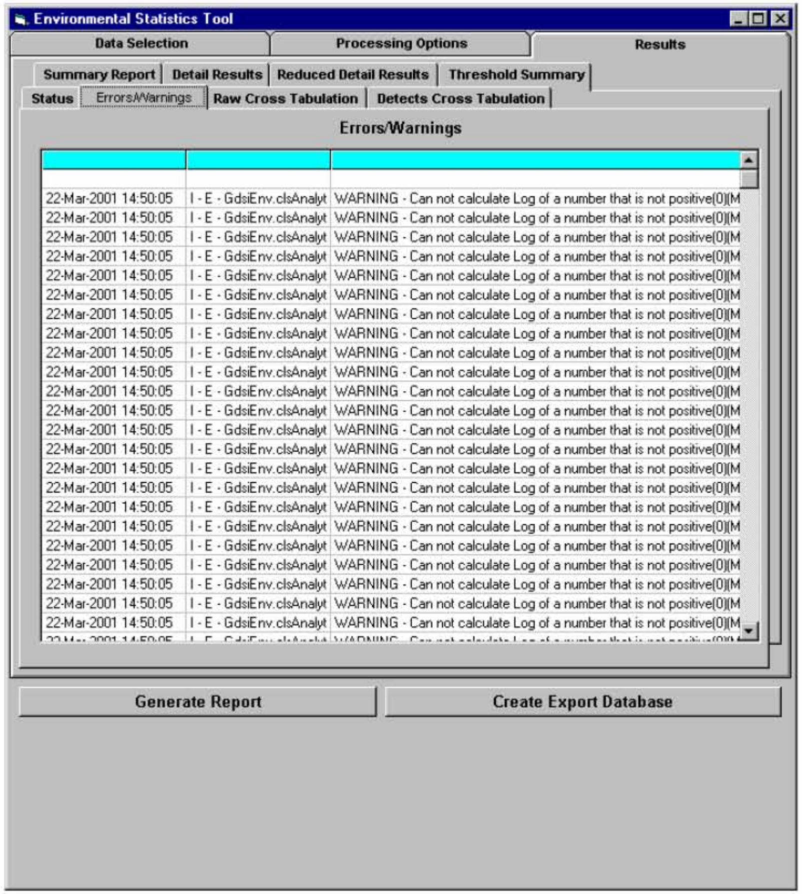
Common errors and their causes are described below:

A) ***Can not calculate Log of a number that is not positive(0) (METAL,Cyanide)*** - this error would occur if you have any records with a value of zero. The error statement identifies the analysis group and analyte that had the issue.

B) ***Can not calculate Log of a number that is not positive(-1) (WCHEM,pH)*** - If EnStat is unable to convert a record’s value into the preferred unit (because a conversion factor to convert from the record’s unit into the preferred unit does not exist in EnDat’s Unit Conversion Table) then EnStat replaces the record’s value with “-1”. This leads to the error you see above when EnStat attempts to calculate the logarithm of this value. The error statement identifies the analysis group and analyte that had the issue.

C) ***No preferred unit for Matrix (TI) Analysis Group (EXPLO)*** - If a preferred unit is not defined in EnDat’s Preferred Units Table for one of the matrix/analysis group combinations in your query then this error will occur.

D) ***No reporting limits in sample collection*** - If you are requesting the output of the maximum or minimum reporting limit and the reporting limit (detection limit) field is empty for this record in EnDat than this error will occur.



Note: the errors that are listed on this subtab are not ALL the errors in your data set, just the errors that EnStat encountered before it got permanently caught in a loop. Once you repair the data for these errors in EnDat there may be other errors that will appear on the next query attempt.

ENSTAT OUTPUT FORMATTING OPTIONS:

There are three macro templates that you can download off the LAN to assist you in formatting the EnStat output. All three templates are located at: NER\Orion\Proj\CLEANII\DATAMGMT\Macros.

“Raw, Detects & Exceedance Tables from EnStat Output.xls”

This macro template uses the data from EnStat’s “Raw Cross Tabulation”, “Detects Cross Tabulation”, and “Summary Report” subtabs to create formatted Raw, Detects, and Exceedance tables complete with heading titles and qualifier definitions in the footers. In order to create the Exceedance table you must select the required threshold criteria from the Threshold subtab AND the Regulatory Criteria Upper Limit option from the Output Options subtab so the required threshold criteria appear in EnStat’s “Summary Report”.

“HHRA Tables from EnStat Output.xls”

This macro template uses the data from EnStat’s “Raw Cross Tabulation”, “Detects Cross Tabulation”, and “Summary Report” subtabs to create formatted and completed HHRA Table 2’s and 3’s, Raw, Detects, and Exceedance tables complete with heading titles and qualifier definitions in the footers. A Stat Check macro is included that verifies that the EnStat calculated statistics are correct. In order for the HHRA tables to be completed correctly you must select the button labeled “Human Health” on the Output Options subtab.

“EcoRisk Tables from EnStat Output.xls”

This macro template uses the data from EnStat’s “Raw Cross Tabulation”, “Detects Cross Tabulation”, and “Summary Report” subtabs to create formatted and completed Eco Risk Summary and Screening Tables and Raw, Detects, and Exceedance tables complete with heading titles and qualifier definitions in the footers. A Stat Check macro is included that verifies that the EnStat calculated statistics are correct. In order for the EcoRisk tables to be completed correctly you must select the button labeled “Eco Risk” on the Output Options subtab.